EFFICACY OF WHOLE-BODY SUSPENSION TRAINING ON ENHANCING FUNCTIONAL MOVEMENT ABILITIES FOLLOWING A SUPERVISED OR HOME-BASED 8-WEEK TRAINING PROGRAM

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SHELBY MARIE SAYLOR

ABSTRACT

Suspension training is a tool that can be used to work every muscle group in the body through various components of functional movement including balance, stability and coordination. No previous studies have analyzed the effectiveness of a whole-body suspension training program on functional movement abilities. **Purpose:** The primary purpose of this study was to determine the effectiveness of suspension training on enhancing functional movement. The secondary purpose was to assess if suspension training is more effective in a supervised program or a home-based program. **Methods:** Twenty-one healthy subjects, ages 18-32 (11 male, 10 female) with no recent history of resistance training participated in this investigation and were randomly assigned to either a home-based or a supervised group after completing their initial pre-test that included body composition testing and a Functional Movement Screening (FMS) test. Each subject that was randomized into the home-based group was taught how to set up the suspension training system on a door way and how to complete each of the 10 exercises correctly. After this initial session in the laboratory the home-based group subjects were then supervised once in their home on how to set up the system in their home, as well as reminded of the correct procedures for each exercise in the program. The supervised group began their introductory session 2-4 days after their initial FMS
pre-test. The 8-week training program consisted of a 5 minute warm-up followed by 10 exercises targeting each major muscle group in the body including: low row, chest press, Y-fly, triceps press, biceps curl, squat, lunge, calf press and side plank. Each exercise session was followed by 5-10 minutes of whole-body static stretching. Upon the completion of the 8-week suspension training program, each subject went through post-testing that included body composition testing and a FMS test. A repeated measures ANOVA was used to analyze the data. \textbf{Results:} There was a significant improvement in FMS scores across the total sample of subjects after suspension training ($p=.004$; pre$=16.4$, post$=17.5$), with no significant differences in improvement between the home or supervised group ($p>.05$). There was a significant increase in lean mass across the total sample of subjects ($p=0.03$), with no differences between groups ($p>.05$). \textbf{Conclusions:} When completed as a whole body exercise program over an 8-week period, suspension training can improve functional ability and increase lean mass in both a supervised and a home-based setting.
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CHAPTER I
INTRODUCTION

Functional ability is defined as “the actual or potential capacity of an individual to perform the activities and tasks that can be normally expected” (Kirch, 2008). Some fundamental aspects of functional ability are balance, stability and coordination. Functional movement is essential to both athletes and individuals of all shapes and sizes. It affects one’s ability to age gracefully, as well as compete at all levels of sports performance. Functional movement has been known to be important, but until recently, tests to analyze functional movement have been vague, limited, and unreliable, making research on functional ability difficult. However, due to the development of the functional movement screening (FMS) test, fundamental movement patterns can be assessed and scored accurately (Cook, Burton, Hoogenboom & Voight, 2014a & 2014b). The span of the FMS test as a screening tool reaches from potentially pre-participation screenings for high school athletics (Letafatkar, Hadadnezhad, Shojaedin & Mohamadi, 2014) to professional athletes (Kiesel, Plisky & Butler, 2011).
Until recently, the main method of improving functional fitness has been strength training (Levinger, Jerums, Selig, Goodman & Hare, 2007). However, observations of single exercise bouts suggest that suspension training provides a superior stimulus for muscular activation as compared to traditional strength training (Byrne et al., 2014; Mok et al., 2015; Snarr and Esco 2013; Snarr and Esco, 2014). When assessing other aspects of sports performance, such as power, strength and velocity, suspension training has been shown to be just as effective as traditional resistance training (Maté-Muñoz, Monroy Antón, Jodra Jiménez & Garnacho-Castaño, 2014). Over the years, many different pieces of exercise equipment have been marketed that allow the body to train on an unstable surface. Including, but is not limited to, wobble boards, BOSU balls and Swiss balls. While exercising on an unstable surface has been shown to elicit greater muscle activity, particularity in the “core” or “torso” musculature to maintain a straight body position in healthy adults (McGill, Cannon and Anderson, 2014b; Snarr & Esco, 2014), very little research has been conducted to assess the efficacy of using an extended suspension training program to increase functional ability.

This study sought to determine if there would be an improvement in FMS scores after prolonged suspension training; and also, if improvements differed between suspension training in a home-based exercise setting versus a supervised exercise setting.
PURPOSE OF STUDY

The purpose of this study was to determine the effectiveness of suspension training on enhancing functional movement, as well as to assess if suspension training is more effective in a supervised or a home-based program.

HYPOTHESIS

- It was hypothesized that suspension training will enhance FMS scores.
- It was hypothesized that there will be no difference in FMS scores between the supervised and home based program.

SIGNIFICANCE OF STUDY

Fundamental aspects of functional ability, such as balance, stability and coordination greatly influence how well an individual can perform everything from activities of daily living to elite sporting events. Conditions associated with loss of functional ability including, but not limited to injury, stroke, or neuropathy, typically lead to a decline in general health and physical activity, as well as diminished quality of life. Treatment for these conditions is often expensive, and requires travel to rehabilitation facilities, and use of specialized equipment. Alternatively, suspension training devices are easily transportable and inexpensive, making them ideal for rehabilitation programs. The findings of this study may help to develop a preventative or therapeutic mode of exercise to offset the decline in functional ability that results from health conditions and/or aging.
DELIMITATIONS

• Twenty-one healthy individuals (10 males, 11 females) ages 18-40 years. who were not currently involved in a regular resistance training program.

• Groups were randomly assigned using a random envelope draw system, separated by gender.

• Both the home-based and the supervised groups performed the same exercises, two times per week, for 8-weeks with at least 48 hours between each session.

• The home-based group had two supervised sessions initially to become familiar with the exercises used in the study. The first session will be at Cleveland State University and the second was at the subject’s house to ensure proper set up of the suspension training device in their home.

• Administrators were TRX certified and had completed the TRX Functional Training Course
CHAPTER II
LITERATURE REVIEW

This study sought to determine if Functional Movement Screening (FMS) scores are improved after an 8 week suspension training program. This study also sought to determine if there would be a difference in FMS score changes between performing the suspension based program in a supervised versus a home-based setting. The effects of suspension training on body composition was a secondary focus.

EFFECT OF EXERCISING ON AN UNSTABLE SURFACE

There has been very little research on the efficacy of suspension training and functional movement. However, there have been a few studies assessing an array of instability devices, including suspension training systems, on muscle activation.

Snarr and Esco (2014) evaluated electromyographical (EMG) tracings in 12 healthy men ages 20-27, for five variations of plank exercise including a traditional plank (REG), elbows on swiss ball plank (EB), feet on swiss ball plank (FB), elbows in suspension device plank (ET) and
feet in suspension device plank. (FT) Muscle activation in the rectus abdominus (RA), external oblique (EO) and the lumbosacral erector spinae (LSES) were assessed. The findings were that instability devices elicit more muscle activity during plank variations in the RA (EB 65.0 ± 44.0; FB, 71.8 ± 51.5; ET, 91.2 ± 65.7; FT, 55.1 ± 45.3), EO (EB, 59.1 ± 40.9; FB, 84.5 ± 45.4; ET, 75.9 ± 34.3; FT, 63.5 ± 47.1) and LSES (EB, 17.5 ± 9.56; FB, 15.5 ± 8.23; ET, 21.3 ± 10.8; FT, 12.7 ± 6.18) in comparison to the traditional plank (RA, 36.1 ± 28.1; EO, 42.0 ± 21.6; LSES, 10.0 ± 4.10) (Snarr & Esco, 2014).

Bynre et al. (2014) also examined the effect of suspension training on muscle activation of the front plank. The study enrolled 21 healthy subjects (10 males, 11 females), 19-24 years of age, and had them complete two sessions of suspension training, the first session for familiarization and the second session for data collection. The variations of the plank included a traditional plank, feet-in straps plank, elbows in straps plank and both elbows and feet in straps plank. Muscle groups analyzed were the RA, EO, rectus femoris (RF) and serratus anterior (SA). The results showed that the instability provided by the suspension training straps produced a significant increase in muscle activation of all four muscle groups in comparison to the traditional plank. It was noted that the muscles of the abdominal wall (RA, EO) elicited a greater degree of change in comparison to the RF and SA. This suggests that instability devices, primarily the suspension training device in this case, increase muscle activation, therefore potentially increasing “core” strength over an extended period of time (Bynre et al., 2014).
Snarr and Esco (2013) evaluated EMG tracings of suspension pushups (SPUs) versus traditional pushups (TPs). The subjects included 21 healthy and physically active males (N=15) and females (N=6), ages 21-28 years, with at least six months of resistance training experience. EMG tracings from the prime movers of the glenohumeral joint (pectoralis major and anterior deltoid) and the humeroulnar joint (triceps brachii) were obtained. Once maximum voluntary contractions were performed and all muscle groups were normalized, subjects were randomized to which exercise variation to perform first and taught how to correctly perform each variation. Both variations of the push up were performed at one push up every three seconds timed by a metronome, with both EMG readings taken in the same day. The results showed that EMG values were significantly higher during the SPU compared to the TP (pectoralis major, 3.08 ± 1.13 mV SPU, 2.66 ± 1.05 mV TP; anterior deltoid, 5.08 ± 1.55 mV SPU, 4.01 ± 1.27 mV TP; triceps brachii, 5.11 ± 1.97 mV SPU, 3.91 ± 1.36 mV TP), indicating that suspension training may be effective in increasing the intensity of push up exercises (Snarr & Esco, 2013).

Since exercising on an unstable surface has been shown to increase core muscle activation, it has been a topic of conversation for researchers in regards to aging adults. Gaedtke & Morat (2015) sought to determine the feasibility of a 12-week TRX-OldAge exercise program to help adults over the age of 60 years with functional components that deteriorate with age, such as balance, gait + muscular strength, as well as to decrease musculoskeletal associated pain. There were 11 subjects recruited (9 males, 2 females) ages 60-73 years. The exercise protocol included seven exercises modified to match the abilities of the subjects, as well as target the
whole body. As strength increased, subjects went through 3-4 progressions of each exercise to maintain a suitable difficulty. Subjects performed the program three times per week, for 30 minutes for 12 weeks. The results showed that the TRX-OldAge program had an overall positive effect on balance (45%) and strength (73%), according to a self-reported 6 point Likert scale. In regards to flexibility, 73% of the subjects recognized strong improvements. Gaedtke & Morat (2015) also found that almost 91% of the subjects wanted to continue the TRX-OldAge program.

One study suggested that stable surfaces are more conducive for pulling exercises such as a pull up or chin up. McGill et al. (2014a) compared muscle activity and spine loading during pulling exercises on stable versus unstable contact points using suspension training straps. Fourteen males, ages 19-23 years completed a series of 11 different pulling exercises on a stable surface and with a TRX suspension device. The results suggested that suspension straps are not as influential in muscle activation for pulling exercises as they are in pushing exercises. Specifically, the chin up and the pull up elicited a greater increase in muscle activity in comparison to the reverse fly, which elicited less than 20% torso muscle activity (McGill et al., 2014a).

Fenwick, Brown and McGill (2009) assessed the effectiveness of three different rowing variations, one of which included a suspension training device. The study recruited seven healthy, recreationally active men, average age = 27 years. Prior to testing, proper form of each of the variations of the rowing exercise was taught and assessed in each subject. The three variations of the row were an inverted row on a suspension device, a bent-over barbell row, and a standing single-arm cable row.
Muscle activity was monitored using a 16-lead EMG system. The electrodes were located over eight muscle groups typically used in the rowing exercise including: rectus abdominis, external and internal obliques, latissimus dorsi, thoracic erector spinae, lumbar erector spinae, gluteus medius, gluteus maximus, rectus femoris and biceps femoris. Fenwick et al. (2009) determined that the inverted row exercise on the suspension training device required less spinal load and shear force than the other two rowing exercises, while still stimulating trunk muscle activation, making it ideal for improving functional movement. The researchers also found that greater muscle activation in the latissimus dorsi and thoracic erector spinae occurred during the inverted row compared to the other two exercises. The other two rowing exercises elicited significant muscle activation; however, this was at a cost to the subject. The barbell row elicited a large amount of spine loading and spine stiffness (3566 N) in comparison to the other two rowing exercises, and the one-armed cable row merely increased the torsion of the trunk musculature (inverted row, 2339 N; 1-armed cable row, 2457 N) (Fenwick et al. 2009).

Beach, Howarth & Callaghan (2008) also assessed the muscular contribution to low back loading and stiffness during standard and suspension push ups. The study enrolled 11 recreationally active men, ages 26-28 years, and had each of them perform one set of 8-10 repetitions for standard push ups and one set of 8-10 repetitions for suspended push-ups. Infrared light-emitting diodes (IREDS) were placed on the hands, wrists, elbows, shoulders, head, torso, sacrum and T12/L1 intervertebral joints to collect data for lumbar spine rotation. EMG tracings were also recorded from the erector spinae, rectus abdominus, external and internal
obliques and the latissimus dorsi. The results showed that the suspended push ups elicited a higher level of muscle activation in the abdominal wall and latissimus dorsi when compared to the standard push up. The rectus abdominus showed a peak muscle activation level of $25.1 \pm 7.1$ for the standard push up, whereas the suspended push up, peak level of $61.6 \pm 13.0$. The latissimus dorsi peak muscle activation was $10.0 \pm 1.6$ for the standard push-ups whereas for the suspended push-up it showed a peak muscle activation level of $17.5 \pm 3.3$. The results from this study showed that core muscular activation increased significantly when performing suspended push up in comparison to standard push ups (Beach et al., 2008).

**FUNCTIONAL MOVEMENT SCREENING AND FUNCTIONAL ABILITY**

The Functional Movement Screening (FMS) test is a new tool that could potentially help predict future injuries in athletes and the general population. It evaluates a multitude of functional movements such as trunk stability, joint range of motion and flexibility, as well as body symmetry during basic functional movements. It has been accurate in predicting injury (Chimera, Smith & Warren, 2015; Garrison, Westrick, Johnson & Beneson, 2015), as well as in recognizing deficiencies in athlete's movement patterns that could be improved with training (Bardenett et al., 2015; Choi & Shin, 2015). A score at or below 14 on a scale of 0-21 on the FMS test has been shown to be a predictor of future injuries (Chorba, Chorba, Bouillon, Overmyer & Landis, 2010; Kiesel et al., 2007).
Parenteau-G et al. (2014) assessed reliability of the FMS test as a tool for screening 28 young (13-16 years old) male elite ice hockey players. The subjects completed the FMS test and a randomly assigned field rater scored their results. The FMS sessions were video recorded from a front and side view and later examined by two separate video raters. The videos were rated once the day of the test, and again 6-weeks later to assess inter and intra-rater reliability. The composite analysis showed that the overall percentage of test agreement between the test criteria was 86.5% for inter-rater reliability and 97.5% (rater 1), 93.9% (rater 2) for test-retest reliability. These results show that the FMS test is a reliable test for young, elite male hockey players (Parenteau-G et al., 2014).

Shultz, Anderson, Matheson, Marcello and Besier (2013) evaluated the test-retest and interrater reliability of the FMS test by comparing scores during a live session and video recording of that same session. The researchers recruited 39 (21 females, 18 males) Division I NCAA varsity athletes, ages 18-21 years, to complete the study. To test interrater reliability, each athlete was tested two times, one week apart, by the same rater. Five other raters then later assessed first session via a video recording taken at the time of the test. The results of the study showed good reliability for test-retest and an excellent reliability for the live-versus-video session. However, the results also showed that there was poor interrater reliability (Shultz et al., 2013).

Kiesel et al. (2011) determined whether or not FMS scores would improve in 62 professional American football players after following a standardized off-season
intervention program. Each player followed a structured 7-week team off-season intervention, as well as an individualized training program. The 7-week program included four days of supervised training, as well as two optional days. The individualized programs were created in an attempt to balance any asymmetries in the subject’s movement patterns according to the initial FMS scores. After following the 7-week intervention, a significant number of players exhibited an increase in FMS scores, as well as improvement in their movement symmetry. At the baseline test, only seven players had a FMS score greater than 14, which is the threshold for a higher risk of injury. After the intervention 39 subjects had a score greater than 14.

When comparing different positions on the team, linemen increased their mean FMS score by 3 points (pre-intervention mean, 11.8; post-intervention mean, 14.8) while non-linemen increased their FMS score by 1.5 points (pre-intervention, 14.8; post-intervention, 16.3). Prior to the study, only 31 players were free of asymmetries in their FMS scores. After the intervention, this number increased to 42 players (Kiesel et al., 2011).

Primary care doctors are beginning to prescribe exercise as a form of preventative medicine to improve body composition, minimize risk for disease, and increase functional abilities. Improved functional ability can increase energy and reduce the risk for falling and disease. Atay, Toraman and Yaman (2014) assessed the effect of physical activity level on functional movement abilities in 120 sedentary elderly individuals, ages 50-70 years, randomly assigned to a control (N=69) or an intervention group (N=51). The intervention group was instructed to complete individualized exercise prescription programs on their own in a home
setting and were trained for 30 minutes on physical activity prior to beginning their prescribed program. They met with doctors monthly for 6 months to discuss ways to increase their physical activity and exercise prescriptions were updated as necessary. The results showed that lower extremity strength, measured by a repetition maximum, (pre, 14.74 ± 5.35; post, 21.55 ± 4.49), upper extremity strength (pre, 25.74; post, ± 43.35 ± 10.30), lower extremity flexibility (pre, -4.22 ± 5.44; post, 3.45 ± 5.38) and balance (pre, 36.52± 28.84; post, 74.51± 25.12) all improved significantly, along with anthropometric measures such as waist circumference (pre, 99.72± 13.39; post, 94.63 ± 13.71), hip circumference (pre, 111.28±13.10; post, 105.61± 11.99) and Body Mass Index (pre, 30.26 ± 5.52; post, 28.17 ± 4.68) in the intervention group (Atay et al., 2014). With the increases in strength, flexibility and balance it was concluded that the intervention group had a significant increase in functional ability.

SUPERVISED VERSUS HOME BASED EXERCISE PROGRAMS

Traveling to a fitness facility or rehabilitation center can be a barrier for many individuals. Exercise equipment is often too expensive and/or bulky for one’s home. By making home-based exercise programs that are efficient, effective and low-cost, one can potentially increase adherence to exercise programs. Research has shown that those who participate in a home-based exercise or rehabilitation program have high retention rates when subjects are held accountable (Escolar-Reina et al., 2010; Freene, Waddington, Chesworth, Davey and Cochrane, 2013).
Dolan et al. (2006) evaluated the effects of a supervised home-based 16-week aerobic and progressive resistance training program in 40 women infected with HIV (18-60 years old). Each subject had a waist-to-hip ratio of .85 or more, as well as a self-report of abdominal fat distribution. Subjects were randomized into an exercise group (N=10) or a control group (N=20). Exercise equipment was provided to the subjects who were in the home exercise program who exercised 3 times per week in 2 hour sessions for 16 weeks. Aerobic exercise intensity was at a percentage of estimated maximal heart rate (MHR); one-repetition maximum (1-RM) was obtained in preliminary testing. The aerobic exercise began with a 5 minute warm up at 50% MHR. Then the subject would cycle at 60% MHR for 20 minutes during the first two weeks, progressing to 75% MHR. The exercises that were completed included knee-hip extension, bench press, knee flexion, lateral raises, standing calf raises and arm curls. The intensity increased every two weeks for the first 6 weeks, starting at 60% 1-RM and then to 70% two weeks later, and eventually 80% two weeks after that. For the first 3 weeks of the exercise program, subjects completed 3 sets of 10 repetitions of each exercise; Then the volume increased to 4 sets of 8 repetitions. After the 16 week program, Dolan et al. (2006) found that strength, aerobic capacity (exercise group 1.5± .08 mL/kg/min versus control group -2.5 ±1.6 ml/kg/min) and body composition (waist circumference for the control group -1.0±.06 vs. control group 1.5 ±1.0 cm) were all improved in the exercise group in comparison to the control group (Dolan et. al, 2006).

Freene et al. (2013) compared self-report physical activity in 76 middle aged adults (50-65 years old) completing a 6 month supervised group or physiotherapist
led home-based exercise program. Each participant was instructed to continue exercise outside of their exercise sessions and to try and maintain 150 minutes of moderate to vigorous physical activity. Accelerometers and a self-administered Active Australia Survey were provided to the subjects to complete over a 7-day period. The results showed that the physiotherapist-led home-based exercise program had better agreement to the physical activity guidelines outside of their exercise sessions (Freene et al., 2013).

Spector and Battaglini (2015) assessed the feasibility of delivering a 16-week home-based exercise program to African American breast cancer survivors who did not currently meet exercise recommendations. Participants were sedentary African American women, ages 30-60 years, who had completed primary treatment for Stage 0-IIIA breast cancer within the last two years. The 16-week program included both aerobic and strength training components. Recruitment, retention, and adherence rates, participant acceptance and safety were all evaluated. Baseline and post-intervention health and fitness testing was completed. After the 16-week exercise program, there was a 76% retention rate, 70% adherence to walking goals, and 51% adherence to weekly resistance training goals. Although the resistance training adherence was low, the intervention succeeded in increasing physical activity levels to the recommended 150 minutes of moderate-intensity physical activity per week. These findings suggest that home-based exercise programs are a feasible option for integrating exercise into African American women breast cancer survivors’ weekly routine (Spector & Battaglini, 2015).
Hügli et al. (2015) assessed the adherence to home exercises in patients suffering from non-specific low back pain (NSLBP). Twenty patients, ages 18-65 years, (females=8, males=12) who had experienced NSLBP for more than four weeks volunteered for this study. Subjects were randomly assigned to either a physiotherapy (PT) led group or a home exercise (HE) group. Self-assessed adherence was measured using a home exercise diary. All subjects logged the date as well as the duration of exercise. The exercise programs both consisted of nine therapy sessions geared towards improved movement control and awareness of the lumbar spine. The results of the study showed that while there was a minor difference in the duration of exercise among the exercise groups (HE= 9 minutes 4 seconds; PT= 4 minutes 19 seconds), there was no significant difference among overall adherence. Both groups showed similar improvements in perceived disability, as well as movement control of the lumbar spine (Hügli et al., 2015).

RESISTANCE TRAINING AND BODY COMPOSITION

Resistance training can decrease fat mass and increase lean mass (Hanson et al., 2014; Swanepoel et al. 2013; Ucan, 2014). Decreased fat-mass can increase mobility, which can in turn, improve functional movement.

Hanson et al. (2014) assessed the effects of resistance training on physical function, strength, power, muscle volume and body composition. 35 men and 46 women, ages 65-85 years, volunteered to participate in this study. Fifty of the subjects who completed baseline testing returned for follow up testing (men, n= 23; women, n=27). Body composition was estimated using dual-energy X-ray absorptiometry
(DEXA), muscle volume was analyzed using computed tomography (CT), strength was assessed using 1RM tests, and physical function via a battery of tests such as the 6-m walk test, five chair stands, get up and go, and the stair climb test. Each resistance training program was broken up into two phases. The first phase was about 10 weeks and consisted of 30 sessions and the second phase was about 12 weeks and consisted of 36 sessions. Each phase consisted of a 2 minute warm up on a stationary bike followed by 5 sets of various repetitions at 85% 1RM with respective rest periods, individualized for each participant. Upon completion of the study, there was a significant increase in leg press strength, power and lean mass. Specifically, lean mass increased from an 49.8 ± 1.4 (kg) at baseline testing to 50.4 ± 1.5 (kg) after the resistance training program. This only further concludes that resistance training is an effective means of increasing lean mass.

In summary we can see that over the years resistance training has played a large role in not only increasing an individual’s lean mass but also improving their functional abilities. Being that there have been multiple studies analyzing as well as verifying the effectiveness of muscle activation in regards to suspension training one can assume that it could be an alternative form of resistance training. With that being said it would be interesting to research in depth the effectiveness of suspension training on functional abilities as well as lean mass. The literature has been inconclusive in stating whether in-home or supervised exercise programs are more effective. This allows speculation as to whether or not one method is actually better than the other.
CHAPTER III

METHODOLOGY

STUDY DESIGN

This study utilized an experimental research design. The independent variable was the exercise location (home-based versus supervised) and dependent variables were functional movement screening (FMS) test scores and body composition. Subjects were randomly assigned to either the home or supervised group.

SUBJECTS

A convenience sample from Cleveland State University was obtained. Participants were recruited through word of mouth, advertisements via flyers (Appendix A) Exercise Science Student Association Facebook page, and an online university newsletter that was sent to faculty and staff that participate in the Fitness for Life program. Twenty-one Cleveland State University students of both genders (10 male, 11 female) were recruited to participate in this study. Participants’ ages ranged from 18-34 years. Potential subjects were excluded if they had any cardiovascular or metabolic disease, orthopedic complications, or were already participating in a regular resistance training program.
All eligible participants signed an informed consent form (Appendix B) approved by the Cleveland State University Institutional Review Board (Appendix C) and filled out a pre participation screening form derived by the American Heart Association (AHA) and the American College of Sport Medicine (ACSM) (Appendix D). Subjects were instructed to not exercise for at least 24 hours prior to pre and post functional movement screening. Participating subjects had to be willing to participate for the full 8 week training program.

Functional ability was assessed before and after the training using the functional movement screen (FMS) test (Appendix E). The FMS is a measurement tool used to assess basic motor function by observing basic movement abilities. The FMS also allows for the identification of asymmetries in movement and underlying neuro-muscular imbalances or deficiencies. This test is comprised of seven different simple movement patterns that require a high degree of stability and mobility when performed properly. The FMS movement pattern tests utilizes seven tests that allow an individual to score between a 0 and a 21 (Appendix F) depending on one’s ability to complete the movement pattern with or without pain. The seven movement patterns included: deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability push up and rotary stability. There are also clearing tests for the shoulder mobility test, trunk stability push up test (spinal extension clearing), and the rotary stability movement pattern test. The tests are scored on a scale of 0-3, unilaterally and bilaterally, depending on the test. If at any point the subject felt pain during the movement test or the clearing, they received a zero. If the subject could not complete the clearing test without pain they received a zero
for that particular movement pattern. Subjects were graded on their ability to perform each movement pattern before and after the 8-week suspension-training program. This testing was carried out at the CSU Human Performance Laboratory and took approximately 30 minutes.

Body composition was estimated before and after training to determine any changes in lean body mass. Suspension training is a form of resistance training, and therefore may be associated with increases in muscle mass. Body composition was assessed using air displacement plethysmography (Bod Pod) in the CSU Human Performance Laboratory. This procedure took approximately 10 minutes to complete and required the subject to dress in compression clothing or a swim-suit. Subjects were instructed to refrain from eating, drinking and exercising for 3 hours prior to body composition testing.

**PROCEDURES FOR TESTING AND GATHERING DATA**

The training program consisted of two weekly whole-body suspension-training sessions composed of 3 sets of 10 different exercises targeting all of the major muscle groups including the chest, back, shoulders, arms, hips, legs, and abdominals which took approximately 30-60 minutes to complete.

10 of the 21 participants were randomly selected to train at home after familiarization, while the other 11 participants trained at Cleveland State University under the supervision of study personnel. Subjects randomly assigned to the home-based exercise program were issued a home suspension training apparatus for the duration of the study, and the first two training sessions involved proper instruction
for using the apparatus. The first training session for the home group was completed at Cleveland State University and the second training session was completed at the subject’s home under the supervision of the study personnel to ensure proper home set up in a approved, safe location.

Appendix G shows the TRX suspension training system (Block, 2011) that was utilized for the exercises. Seven of the 10 exercises utilized the handles of the TRX home suspension trainer and the other three exercises utilized the foot cradles. The straps for the supervised group were anchored to a wall mount while the straps for the home-based group were anchored in a door way. All home-based group subjects were instructed on proper technique in regards to mounting the straps in a door way.

**DATA ANALYSIS**

Descriptive statistics were obtained. Inferential statistics (repeated measures ANOVA) were used to assess treatment differences due to the independent variable, suspension training location (supervised vs. home-based), on the dependent variable, FMS scores. and body composition. SPSS (version 22.0) was used for all analyses with .05 used as the level of significance.
CHAPTER IV
RESULTS AND DISCUSSION

RESULTS

Twenty-one subjects, 10 males and 11 females (ages 18-32 years) volunteered to participate in this study to determine the effects of an 8-week suspension training program on functional movement in home versus supervised exercise groups. Of the original 21 subjects, 4 dropped out of the study due to various pre-existing medical conditions/personal reasons. Therefore, the remaining data collected was on 8 males and 9 females (ages 18-32 years). The subject characteristics (age, weight and height) are shown in Table 1.

TABLE 1. SUBJECT CHARACTERISTICS (mean ± SD).

<table>
<thead>
<tr>
<th></th>
<th>Ages (years)</th>
<th>Weight(kg)</th>
<th>Height (cm)</th>
<th>Lean Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females (N=9)</td>
<td>23.8± 3.7</td>
<td>64.3±10.9</td>
<td>165.1±9.7</td>
<td>48.1±8.0</td>
</tr>
<tr>
<td>Males (N= 8)</td>
<td>19.6 ± 1.1</td>
<td>68.9± 5.2</td>
<td>174.1±8.1</td>
<td>57.7± 6.5</td>
</tr>
</tbody>
</table>
Compliance to the exercise program was recorded via a weekly log. The average amount of days missed for the total sample was .59 days, the home group was .25 days and the supervised group was .89 days.

There was a significant improvement in FMS scores across the total sample after suspension training (p = .004; pre=16.4, post=17.5). When assessing both groups individually, the supervised group increased significantly, pre/post FMS supervised (p=.04), while the home group did not, pre/post FMS home group (p=.06) with the level of significance set at .05. These findings are shown in Figure 1.
Figure 1 Change in FMS scores over time for the home vs. supervised groups, as well as for the total sample (All). The total sample and the supervised group reached improved significantly (total sample, p = .004; supervised group, p = .04).

The results for each FMS exercise (deep squat, hurdle step, inline lunge, shoulder mobility, trunk stability push up, active straight-leg raise and rotary stability) for the pre and post exercise intervention are shown in Table 2 Two individual tests showed a significant increase in pre/post FMS scores (Hurdle Step Right, p = .03; Rotary Stability Right, p = .02).
The pre/post intervention results for individual FMS exercise scores between groups are shown in Table 3. Two individual FMS tests showed a significant interaction between the home and supervised group (Shoulder Mobility Left, $p= .034$; Trunk Stability Push Up, $p= .030$). This can be seen in Figure 2 and Figure 3.

![Interaction Between Groups for Shoulder Mobility Left](image)

**Figure 2** Interaction between pre and post shoulder mobility left FMS scores between the home group and the supervised group ($p=.034$).
Figure 3 Interaction between pre and post trunk stability FMS scores between the home group and the supervised group (p=.03).
TABLE 2. COMPARISON OF INDIVIDUAL FMS EXERCISE SCORES FOR PRE/POST EXERCISE INTERVENTION: TOTAL SAMPLE (N=17).

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Pre Mean ± SD</th>
<th>Post Mean ± SD</th>
<th>Significance (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Squat</td>
<td>2.24 ± .56</td>
<td>2.35 ± .49</td>
<td>.362</td>
</tr>
<tr>
<td>Hurdle Step (Left)</td>
<td>2.18 ± .53</td>
<td>2.47 ± .52</td>
<td>.152</td>
</tr>
<tr>
<td>Hurdle Step (Right)</td>
<td>2.24 ± .66</td>
<td>2.65 ± .49</td>
<td>.033*</td>
</tr>
<tr>
<td>Inline Lunge (Left)</td>
<td>2.82 ± .39</td>
<td>3.00 ± .00</td>
<td>.082</td>
</tr>
<tr>
<td>Inline Lunge (Right)</td>
<td>2.88 ± .33</td>
<td>2.94 ± .24</td>
<td>.362</td>
</tr>
<tr>
<td>Shoulder Mobility (Left)</td>
<td>2.82 ± .39</td>
<td>2.71 ± .58</td>
<td>.225</td>
</tr>
<tr>
<td>Shoulder Mobility (Right)</td>
<td>2.76 ± .44</td>
<td>2.88 ± .33</td>
<td>.125</td>
</tr>
<tr>
<td>Trunk Stability Push Up</td>
<td>2.12 ± .86</td>
<td>2.35 ± .86</td>
<td>.149</td>
</tr>
<tr>
<td>Active Straight Leg Raise (Left)</td>
<td>2.53 ± .80</td>
<td>2.59 ± .71</td>
<td>.304</td>
</tr>
<tr>
<td>Active Straight Leg Raise (Right)</td>
<td>2.65 ± .61</td>
<td>2.76 ± .56</td>
<td>.177</td>
</tr>
<tr>
<td>Rotary Stability (Left)</td>
<td>2.12 ± .33</td>
<td>2.18 ± .39</td>
<td>.304</td>
</tr>
<tr>
<td>Rotary Stability (Right)</td>
<td>2.06 ± .24</td>
<td>2.35 ± .49</td>
<td>.021*</td>
</tr>
</tbody>
</table>
TABLE 3. COMPARISON OF INDIVIDUAL FMS EXERCISE INTERACTION:

HOME VS. SUPERVISED.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Pre Home Mean ± SD</th>
<th>Pre Supervised Mean ± SD</th>
<th>Post Home Mean ± SD</th>
<th>Post Supervised Mean ± SD</th>
<th>Interaction (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Squat</td>
<td>2.38 ± .52</td>
<td>2.11 ± .60</td>
<td>2.38 ± .52</td>
<td>2.33 ± .50</td>
<td>.362</td>
</tr>
<tr>
<td>Hurdle Step (Left)</td>
<td>2.13 ± .35</td>
<td>2.22 ± .67</td>
<td>2.38 ± .52</td>
<td>2.56 ± .53</td>
<td>.832</td>
</tr>
<tr>
<td>Hurdle Step (Right)</td>
<td>2.25 ± .71</td>
<td>2.22 ± .68</td>
<td>2.75 ± .46</td>
<td>2.56 ± .53</td>
<td>.645</td>
</tr>
<tr>
<td>Inline Lunge (Left)</td>
<td>2.75 ± .46</td>
<td>2.89 ± .33</td>
<td>3.00 ± .00</td>
<td>3.00 ± .00</td>
<td>.485</td>
</tr>
<tr>
<td>Inline Lunge (Right)</td>
<td>2.87 ± .35</td>
<td>2.89 ± .33</td>
<td>2.87 ± .35</td>
<td>3.00 ± .00</td>
<td>.362</td>
</tr>
<tr>
<td>Shoulder Mobility (Left)</td>
<td>2.87 ± .35</td>
<td>2.78 ± .44</td>
<td>2.50 ± .76</td>
<td>2.50 ± .76</td>
<td>.034 *</td>
</tr>
<tr>
<td>Shoulder Mobility (Right)</td>
<td>2.50 ± .56</td>
<td>3.00 ± .00</td>
<td>2.75 ± .46</td>
<td>3.00 ± .00</td>
<td>.125</td>
</tr>
<tr>
<td>Trunk Stability Push Up</td>
<td>2.13 ± .99</td>
<td>2.11 ± 7.8</td>
<td>2.00 ± .926</td>
<td>2.67 ± .71</td>
<td>.030 *</td>
</tr>
<tr>
<td>Active Straight Leg Raise (Left)</td>
<td>2.25 ± .89</td>
<td>2.78 ± .68</td>
<td>2.38 ± .74</td>
<td>2.78 ± .68</td>
<td>.304</td>
</tr>
<tr>
<td>Active Straight Leg Raise (Right)</td>
<td>2.50 ± .76</td>
<td>2.78 ± .44</td>
<td>2.63 ± .74</td>
<td>2.89 ± .33</td>
<td>.935</td>
</tr>
<tr>
<td>Rotary Stability (Left)</td>
<td>2.13 ± .35</td>
<td>2.11 ± .33</td>
<td>2.25 ± .46</td>
<td>2.11 ± .33</td>
<td>.304</td>
</tr>
<tr>
<td>Rotary Stability (Right)</td>
<td>2.00 ± .00</td>
<td>2.11 ± .33</td>
<td>2.13 ± .35</td>
<td>2.56 ± .53</td>
<td>.169</td>
</tr>
</tbody>
</table>
When analyzing the lean mass changes among subjects between groups, one subject had inconclusive results and therefore was not included in the analysis (N=16). This subject had a substantial amount of body hair in both the pre/post body composition testing that resulted in an error message on the BodPod. There was a significant increase in lean mass of the total sample (p=.03). However, there was no significant changes were seen among each individual group for pre/post test lean mass scores (home=.23; supervised=.075) or group by time interaction. Figure 2 shows these changes.
Figure 4 Changes in lean mass among the home group, supervised group and total sample (all). There was a significant increase in lean mass for the total sample. (p=.03)

Gender was analyzed for all variables and no interaction was found between groups or among all subjects.
DISCUSSION

The results showed significant increases in FMS in the total sample. This indicates that suspension training can be used as another form of exercise intervention to help reduce the likelihood of athletes getting injured during various sports. These results support Kiesel et al. (2011) who found that American football players were able to increase their FMS scores after an individualized 7-week off season exercise intervention program. Both the present study and Kiesel et al. (2011) are important in prescribing exercise to young athletes, as well as those recovering from injuries, because by developing an efficient method of exercise to improve functional movement, the likelihood of these athletes reinjuring themselves decreases (Butler et al., 2013; Chapman, Laymen & Arnold, 2014). The current study also supports the findings of Atay et al. (2014) who found that individuals who exercise regularly for an extended period of time for at least 30 minutes per workout session increased their functional movement patterns, thus decreasing their risk for injury. By increasing functional movement patterns, there is a decrease in various deficiencies that lead to a higher risk of injury (Bardenett et al., 2015). This is why having a higher FMS score is associated with a lower risk of injury.

After completing the study it can be speculated that a whole body suspension training program could increase functional movement abilities such as balance and strength, which could lead to increased FMS scores, and theoretically, a decrease in the likelihood of injury. While more research needs to be conducted to support these findings, current research has demonstrated similar benefits of this type of
training. Gaedtke & Morat (2015) found that after putting 11 elderly subjects through a 12-week training program that utilized suspension training as the method of resistance training, they increased their strength and balance significantly.

While there was no significant interaction between groups to conclude that training in a home or supervised setting was more effective than the other, there was a significant improvement in FMS scores among the supervised group, whereas the home group did improve significantly. This supports the findings of Hügli et al. (2014) who found no difference in exercise adherence and duration between a physiotherapy led and home exercise group for patients with non-specific low back pain. However, these finding somewhat contradict those of Grant, Mohtagi, Johnson & Benenson (2005) who found that after 3 months of minimally supervised versus standard physical therapy rehabilitation programs in post ACL reconstruction patients, the minimally supervised group showed greater improvements in acceptable ranges of motion. With there being minimal differences among improved FMS scores in the current study, it is expected that injury prevention would decrease for both groups. While not significant, there was a trend in the results suggesting that the home group did improve their FMS scores. Therefore, while both groups improved, one method was not significantly better than the other. The current study also contradicts the findings of Dolan et al. (2006) who found that a 16-week home-based exercise program improved physical fitness in women infected with HIV. Dolan et al. (2006) found that strength, body composition, cardiorespiratory fitness and endurance were all significantly improved with the home based exercise program. The current study did not show significant
improvements in body composition or functional movement scores in the home-based group.

An 8-week whole body suspension training program showed to significantly increased lean mass. This supports the findings of Swanepoel et al. (2013) who found that after completing a 12-week resistance training program multiple demographic groups increased their lean mass and decreased their fat mass. Hanson et al. (2014) showed that a 22-week resistance training program significantly increased lean mass as well. This suggests that suspension training can be utilized as an effective method of resistance training. This is beneficial because suspension training is portable, cost-effective and the equipment can be easily stored, making it an ideal piece of equipment for strength and condition programs, recreational facilities and home-gyms. The current study also supports the findings of Ucan (2014) who found that 12 weeks of circuit resistance training increased the total amount of lean mass in active young males. This indicates that different types of resistance training program can affect body composition measures. It would be interesting to look at the effects of a circuit style suspension training program could have on various body composition measures.
CHAPTER V

SUMMARY & CONCLUSIONS

Seventeen subjects completed an 8-week whole body suspension training program in either a home or supervised based setting. Both groups completed the same 10 exercises two times a week and were required to log repetitions for every set. Pre and Post FMS scores and body composition was assessed. There was a significant improvement in FMS scores across the total sample after suspension training (p=.004). When assessing both groups individually, the supervised group increased significantly, pre/post FMS supervised (p=.04), while the home group did not (p=.06). There was a significant increase in lean mass of the total sample (p=.03). However, there was no significant changes were seen among each individual group for pre/post test lean mass scores (home=.23; supervised=.075) nor was there an interaction between the groups.

When completed as a whole body exercise program over an 8-week period, suspension training can improve functional ability in both a supervised setting and a home-based setting. However, outcomes can be expected to be slightly better in a supervised setting for this segment of the population, based on these findings. Also
when completed as a whole body exercise program over an 8-week period, suspension training can increase lean mass and be used as an effective means of resistance training. Since the training was effective at improving functional movement and lean body mass overall, and there were no differences between groups, it can be concluded that suspension training can be useful in both a supervised and home-based exercise program, although further research should be conducted to support these result.

**APPLICATION**

Suspension training can be valuable to fitness and health professionals as a means of home and supervised based resistance training programs. This study adds to the growing research on functional movement as well as the effects of resistance training on lean mass. Currently, many rehabilitation programs utilize expensive equipment that can not be purchased for in-home use. Suspension training offers an affordable and portable alternative to this equipment and can be completed with minimal hands-on training with an exercise professional. When applied to the rehabilitation setting for patients with an array of disabilities, suspension training can provide a safe an effective means of exercise to improve functional movement and increase lean mass. High school and collegiate athletic training programs could also benefit from incorporating suspension training into their strength and conditioning and rehabilitation programs as well. The results of the current study indicate that suspension training increases FMS scores which may reduce injury.
LIMITATIONS

1. Having both researchers certified in the FMS testing procedures could have increased interrater reliability.

2. The subjects were a convenience sample and the sample size was small (N=17). Using a larger number of subjects would increase the generalizability of the results.

3. Due to the nature of suspension training, there is no way to quantify actual force production during the resistance training. Thus, the absolute amount of physical work could not directly be measured.

FUTURE RESEARCH RECOMMENDATIONS

1. Research should be conducted to assess the long-term effects of using suspension training as a resistance training program for improving functional movement and preventing injuries in both athletes and the general population.

2. More research is needed to assess the effectiveness of home-based exercise programs in regards to functional movement and injury prevention. This will allow for a better understanding of the feasibility of home-based rehabilitation programs.

3. Future research is needed to analyze the effectiveness of suspension training on increasing lean mass in various populations. Due to
suspension training’s ease of use, it could replace expensive home-gym equipment with an affordable and easy to store device.
REFERENCES


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APPENDIX A

RESEARCH RECRUITMENT FLYER
Cleveland State University
Study Participants Wanted

Participants are needed for a study looking at the effects of an 8-week suspension-training program on improving functional ability among. We are looking for healthy volunteers meeting the following criteria:

- 18-40 years of age
- Not currently involved in a regular resistance-training routine

The study involves an 8-Week whole-body suspension training program. Training sessions will take place twice weekly and will last approximately 1 hr. The study will also involve a pre and post test Functional Movement Screening Test as well as other basic body composition testing. Upon completion of the 8-week training program participants will receive a $100.00 stipend.

If interested, please contact Shelby Saylor at: s.saylor86@vikes.csuohio.edu
Or call (216) 501-0203
You can also contact Emily Kullman at e.kullman@csuohio.edu 216-687-4854
APPENDIX B

INFORMED CONSENT
INFORMED CONSENT FOR PARTICIPATION

The efficacy of whole-body suspension training on enhancing functional movement abilities following a supervised or home-based training program

Introduction

Thank you for considering participation in this project. Dr. Emily Kullman, faculty in the Department of Health and Performance, and Ms. Shelby Saylor, Graduate Student in the Exercise Science Program invite you to participate in a research study to be conducted in the Human Performance Laboratory at Cleveland State University.

The purpose of this study is to determine the effects of an 8-week home vs. supervised suspension-training program on improving functional ability among healthy individuals.

Suspension training is a relatively new form of resistance exercise that utilizes hanging straps anchored to a fixed point from above, such as the top of a closed door. Suspension training requires individuals to work against their own body weight, and the intensity of the resistance can easily be increased or decreased by adjusting body position or stance. There is some evidence to suggest that single bouts of suspension training exercise provide a superior stimulus for muscular activation as compared to traditional strength training. However there has been no research investigating the effects of prolonged suspension training on functional abilities.

By determining if prolonged suspension training does in fact improve functional ability, we can develop specific training programs aimed at improving functional ability in healthy or disabled
adults, and improve adherence to training programs due to the cost efficiency and convenience of home-based suspension training.

**Procedures**

If you choose to participate in this study, you will be asked to complete 16 exercise sessions using the suspension-training device. Each training session will consist of a brief warm-up, followed by a whole body suspension training exercise routine consisting of 3 sets of 10 different exercises targeting all of the major muscle groups, including: chest, back, shoulders, arms, hips, legs, and abdominals. Training sessions will take approximately 30-45 minutes to complete. The home-based groups will be taught the workout routine in person then will complete the exercises routine twice weekly for 8-weeks. Also, within one week before, and one week following the exercise training, we will perform a functional movement screening test, a body composition analyses, and anthropometric measurements in the CSU Human Performance Laboratory.

If you are assigned to the home-based exercise program, you will be issued a home suspension training apparatus for the duration of the study, and your first two training sessions will involve proper instruction for using the apparatus. The home training kit must be returned upon completion of your training, and the $100 stipend will be withheld until the return of the kit.

Functional ability will be assessed before and after the training using the functional movement screen (FMS) test. The FMS is a valid tool to assess basic motor function by observing basic movement abilities. This test is comprised of seven different simple movement patterns that require a high degree of stability and mobility when performed properly. You will be graded on your ability to perform each movement pattern before and after the 8-week suspension-training program. This testing will be carried out at the CSU Human Performance Lab, and will take approximately 30 minutes.

Body composition will be evaluated before and after training to determine any changes. Body composition is an estimate of the amount of fat and lean mass on a person. We will measure body composition using air displacement plethysmography (Bod Pod) in the CSU Human Performance Lab. This procedure takes approximately 10 minutes to complete and requires you to be dressed in a swimsuit or compression garments.

**Risks and Discomforts**

Potential risks associated with this study include muscle soreness from suspension training exercises. Due to the nature of the suspension training exercises there is risk of tripping, losing grip or falling. As a result of a fall, the attendant risks include: bone fractures, torn ligaments, muscle strains, joint sprains, bruises or joint dislocations. Because of the moderate cardiovascular strain of resistance training, participants may be subject to, in rare instances, fainting, abnormal blood pressure, fatal heart rhythms, stroke or heart attack. Prior to starting the study, you will be required to complete a health risk appraisal questionnaire to screen for any underlying medical issues. In the event you are injured as a result of participation in this research, please notify the
research team and seek medical attention by your primary care physician. The costs of such medical care will be billed to you or your insurance company. There are no plans to provide compensation for lost wages, direct or indirect losses. Cleveland State University will not provide compensation for research related injury.

Benefits
This study may help improve your fitness level. You will also be compensated $100 in the form of a prepaid Visa card for your successful completion of this study.

Confidentiality
To protect your privacy, your name will not be used in any document of the project. A number will be assigned to each subject in place of a name. The information, however, may be used for a statistical or scientific purpose with your right of privacy retained. Only research staff will have access to the data collected. Data will be stored in the Human Performance (Lab PE60B) in a locked file cabinet for a minimum of 3 years.

Participation
I understand that participation in this project is voluntary and that I have the right to withdraw at any time with no consequence. I attest and verify that I have no known health problems that could prevent me from successfully participating in the study. If I have any questions about the procedures I can contact Dr. Emily Kullman at (216) 687-4854 (e.kullman@csu.edu) or Ms. Shelby Saylor at (216) 501-0203 (s.saylor86@vikes.csuohio.edu).

I understand that if I have any questions about my rights as a participant, I can contact Cleveland State University’s Review Board at (216) 687-3630.

Participant Acknowledgement
The purposes, procedures, potential discomforts, risks, and benefits have been explained to me. I have read the consent form or it has been read to me, and I understand it. I agree to participate in this program. I have been given a copy of this consent form. I am at least 18 years old.

Signature: ___________________________ Date: ___________________________

Witness: ___________________________ Date: ___________________________
APPENDIX C

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER
Institutional Review Board Approval Letter

Dear Emily Kullman,

RE: IRB-FY2015-36
Suspension Training and Functional Movement Abilities

The IRB has reviewed and approved your application for the above named project, under the category noted below. Approval for use of human subjects in this research is for a one-year period as noted below. If your study extends beyond this approval period, you must contact this office to initiate an annual review of this research.

Approval Category: Expedited 4
Approval Date: Aug 6, 2015
Expiration Date: Aug 4, 2016

By accepting this decision, you agree to notify the IRB of: (1) any additions to or changes in procedures for your study that modify the subjects’ risk in any way; and (2) any events that affect that safety or well-being of subjects. Notify the IRB of any revisions to the protocol, including the addition of researchers, prior to implementation.

Thank you for your efforts to maintain compliance with the federal regulations for the protection of human subjects. Please let me know if you have any questions.

Sincerely,

Bernie Strong
IRB Analyst
Cleveland State University
Sponsored Programs and Research Services
(216) 687-3624
b.r.strong@csuohio.edu
APPENDIX D

AHA PRE-SCREENING QUESTIONNAIRE
AHA/ACSM Pre-participation Screening Questionnaire
Assess Your Health Needs by Marking all true statements

History
You have had:
- A heart attack
- Heart surgery
- Cardiac catheterization
- Coronary angioplasty (PTCA)
- Pacemaker/implantable cardiac
- Defibrillator/rhythm disturbance
- Heart valve disease
- Heart failure
- Heart transplantation
- Congenital heart disease

Other health issues:
- You have musculoskeletal problems. *(Specify on back)*
- You have concerns about the safety of exercise. *(Specify on back)*
- You take prescription medication(s). *(Specify on back)*
- You are pregnant

Symptoms
- You experience chest discomfort with exertion.
- You experience unreasonable breathlessness.
- You experience dizziness, fainting, blackouts
- You take heart medications

Cardiovascular risk factors
- You are a man older than 45 years.
- You are a woman older than 55 years or you have had a hysterectomy or you are postmenopausal.
- You smoke.
- Your blood pressure is greater than 140/90 mm Hg.
- You don’t know your blood pressure.
- You take blood pressure medication.
- You don’t know your cholesterol level.
- You have a blood cholesterol >240 mg/dl.
- You have a blood relative who had a heart attack before age 55 (father/brother) or 65 (mother/sister).
- You are diabetic or take medicine to control your blood sugar.
- You are physically inactive (i.e., you get less than 30 minutes of physical activity on at least 3 days/week).
- You are more than 20 pounds overweight.

None of the above is true.

Recommendations:
If you marked any of the statements in this section, consult your healthcare provider before engaging in exercise. You may need to use a facility with a medically qualified staff.

If you marked two or more of the statements in this section, consult your healthcare provider before engaging in exercise. You might benefit by using a facility with a professionally qualified staff to guide your exercise program.

Risk Status (Low, Moderate, High):

* Proceed with test if musculoskeletal problems are minor, concerns about safety of exercise are normal, and prescription medications are not for cardiac, pulmonary, or metabolic disease.
APPENDIX E

FMS TEST EXERCISE DEMONSTRATION

Cook, G., Burton, L., Hoogenboom, B. J., & Voight, M. (2014b)
DEEP SQUAT

1. Tibia and upper torso are not parallel | Femur is not below horizontal
Knees are not aligned over feet | Lumbar flexion is noted

2. Upper torso is parallel with tibia or toward vertical | Femur is below horizontal
Knees are aligned over feet | Dowel is aligned over feet | Heels are elevated

3. Upper torso is parallel with tibia or toward vertical | Femur below horizontal
Knees are aligned over feet | Dowel aligned over feet

The athlete receives a score of zero if pain is associated with any portion of this test. A medical professional should perform a thorough evaluation of the painful area.
HURDLE STEP

1. Contact between foot and hurdle occurs | Loss of balance is noted

2. Alignment is lost between hips, knees and ankles | Movement is noted in lumbar spine | Dowel and hurdle do not remain parallel

3. Hips, knees and ankles remain aligned in the sagittal plane | Minimal to no movement is noted in lumbar spine | Dowel and hurdle remain parallel

The athlete receives a score of zero if pain is associated with any portion of this test. A medical professional should perform a thorough evaluation of the painful area.
INLINE LUNGE

1. Dowel contacts not maintained | Dowel does not remain vertical | Movement noted in torso
   Dowel and feet do not remain in sagittal plane | Knee does not touch behind heel of front foot

2. Dowel contacts maintained | Dowel remains vertical | No torso movement noted
   Dowel and feet remain in sagittal plane | Knee touches board behind heel of front foot

3. Loss of balance is noted

The athlete receives a score of zero if pain is associated with any portion of this test. A medical professional should perform a thorough evaluation of the painful area.
SHOULDER MOBILITY

3
Fists are within one hand length

2
Fists are within one-and-a-half hand lengths

1
Fists are not within one and half hand lengths

The athlete will receive a score of zero if pain is associated with any portion of this test. A medical professional should perform a thorough evaluation of the painful area.

CLEARING TEST
Perform this clearing test bilaterally. If the individual does not receive a positive score, document both scores for future reference. If there is pain associated with this movement, give a score of zero and perform a thorough evaluation of the shoulder or refer out.
ACTIVE STRAIGHT-LEG RAISE

3
Vertical line of the malleolus resides between mid-thigh and ASIS.
The non-moving limb remains in neutral position.

2
Vertical line of the malleolus resides between mid-thigh and joint line.
The non-moving limb remains in neutral position.

1
Vertical line of the malleolus resides below joint line.
The non-moving limb remains in neutral position.

The athlete will receive a score of zero if pain is associated with any portion of this test.
A medical professional should perform a thorough evaluation of the painful area.
TRUNK STABILITY PUSHUP

3
The body lifts as a unit with no lag in the spine
Men perform a repetition with thumbs aligned with the top of the head
Women perform a repetition with thumbs aligned with the chin

2
The body lifts as a unit with no lag in the spine
Men perform a repetition with thumbs aligned with the chin
Women with thumbs aligned with the clavicle

1
Men are unable to perform a repetition with hands aligned with the chin
Women unable with thumbs aligned with the clavicle

The athlete receives a score of zero if pain is associated with any portion of this test.
A medical professional should perform a thorough evaluation of the painful area.

SPINAL EXTENSION CLEARING TEST
Spinal extension is cleared by performing a press-up in the pushup position. If there is pain associated with this motion, give a zero and perform a more thorough evaluation or refer out. If the individual does receive a positive score, document both scores for future reference.
ROTARY STABILITY

3
Performs a correct unilateral repetition

2
Performs a correct diagonal repetition

1
Inability to perform a diagonal repetition

The athlete receives a score of zero if pain is associated with any portion of this test. A medical professional should perform a thorough evaluation of the painful area.

SPINAL FLEXION CLEARING TEST
Spinal flexion can be cleared by first assuming a quadruped position, then rocking back and touching the buttocks to the heels and the chest to the thighs. The hands should remain in front of the body, reaching out as far as possible. If there is pain associated with this motion, give a zero and perform a more thorough evaluation or refer out. If the individual receives a positive score, document both scores for future reference.
APPENDIX F

FMS SCORING SHEET

Cook, G., Burton, L., Hoogenboom, B. J., & Voight, M. (2014b)
# The Functional Movement Screen

## Scoring Sheet

<table>
<thead>
<tr>
<th>NAME</th>
<th>DATE</th>
<th>DOB</th>
<th>ADDRESS</th>
<th>CITY, STATE, ZIP</th>
<th>PHONE</th>
<th>SCHOOL/AFFILIATION</th>
<th>SSN</th>
<th>HEIGHT</th>
<th>WEIGHT</th>
<th>AGE</th>
<th>GENDER</th>
<th>PRIMARY SPORT</th>
<th>PRIMARY POSITION</th>
<th>HAND/LEG DOMINANCE</th>
<th>PREVIOUS TEST SCORE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Test</strong></th>
<th><strong>Raw Score</strong></th>
<th><strong>Final Score</strong></th>
<th><strong>Comments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Squat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurdle Step</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inline Lunge</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder Mobility</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impingement Clearing Test</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Straight-Leg Raise</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk Stability Pushup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press-Up Clearing Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotary Stability</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior Rocking Clearing Test</td>
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<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Raw Score:** This score is used to denote right and left side scoring. The right and left sides are scored in five of the seven tests and both are documented in this space.

**Final Score:** This score is used to denote the overall score for the test. The lowest score for the raw score (each side) is carried over to give a final score for the test. A person who scores a three on the right and a two on the left would receive a final score of two. The final score is then summarized and used as a total score.
Figure 1: TRX Home suspension trainer (Block, 2011)
APPENDIX H

SUSPENSION TRAINING EXERCISE DEMONSTRATION
TRX Row Start

TRX Row Finish
TRX Hack Squat Start

TRX Hack Squat Finish
TRX Bicep Curl Start

TRX Bicep Curl Finish
TRX Tricep Extension Start

TRX Tricep Extension Finish (Modified)
TRX Y Fly Start

TRX Y Fly Finish
TRX Lunge Start

TRX Lunge Finish
TRX Hamstring Curl Start

TRX Hamstring Curl Finish
TRX Side Plank Start

TRX Side Plank Finish
APPENDIX I

EXERCISE LOG
*Begin each workout with 5 minutes of warm-up exercises, starting with jogging in place and arm circles for ~3 minutes. Follow this with 30 seconds of TRX squat rows and TRX lunge with chest fly two times (~2 minutes).

<table>
<thead>
<tr>
<th></th>
<th>Week _____</th>
<th>Week _____</th>
<th>Date:</th>
<th>Date:</th>
<th>Date:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Row</strong></td>
<td>3 sets, 15-20 reps</td>
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<td></td>
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<tr>
<td><strong>Chest Press</strong></td>
<td>3 sets, 15-20 reps</td>
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<tr>
<td><strong>Y-Fly</strong></td>
<td>3 sets, 15-20 reps</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>Triceps Press</strong></td>
<td>3 sets, 15-20 reps</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Biceps Curl</strong></td>
<td>3 sets, 15-20 reps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Squat</strong></td>
<td>3 sets, 15-30 reps</td>
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<tr>
<td><strong>Lunge</strong></td>
<td>3 sets, 10-15 reps each leg</td>
<td>/</td>
<td>/</td>
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<td>/</td>
</tr>
<tr>
<td><strong>Hamstring Curl</strong></td>
<td>3 sets, 15-20 reps</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calf Press</strong></td>
<td>3 sets, 15-20 reps each leg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Side Plank</strong></td>
<td>3 sets, 30-60 sec. each side</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

*Follow each workout with 5-10 minutes of whole-body static stretching.