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Group Differences in Balance between Individuals with and without Intellectual Disabilities Following a Progressive Overload Powerlifting Program

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Group Differences in Balance between Individuals with and without Intellectual Disabilities Following a Progressive Overload Powerlifting Program

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Thesis Defense Meeting

A meeting was held ________November 13, 2013_______to consider the thesis

proposal of _______________Thomas Rispoli_______________ entitled

___Group differences in balance between individuals with and without intellectual

disabilities following a progressive overload powerlifting program_______________

The committee composed of ______________Dr. Francis M. Kozub______________,
Chairperson

____Dr. Douglas Collier_______________ and ___Dr. Christopher Williams___________
Faculty Faculty

rejected, accepted, accepted with amendment the enclosed proposal,
(circle one)

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Chairperson Signature

Nov 13, 2013
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Date

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Committee Member

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Committee Member

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ABSTRACT

The purpose of this study was to determine the effects of a core-lifting program on functional balance in persons with intellectual disabilities (ages 27 - 43). This study compared balance results from a group of young adults with intellectual disabilities to a comparison group made up of college aged, typically developing peers (ages 21-27). The intervention lasted six weeks and included one day of progressive powerlifting using three sets of six to eight repetitions as outlined by the Special Olympics Powerlifting Coaches Guide (Special Olympics, 2011). An important research question for this study was to determine if strength improvements in the target population were linked to balance. Results included a lack of association between task analysis scores and balance as measured by force plates ($p > .05$). Further posttest strength findings resulted in the comparison group significantly outscoring the experimental group on maximum squat rate of force development (ROFD), average squat ROFD, and squat maximum force, $F(1, 15) = 5.19$, $p < .05$, $F(1, 15) = 21.99$, $p < .05$, $F(1, 15) = 28.02$, $p < .05$ respectively. With respect to strength changes over the intervention, the experimental group did not improve in strength over the six week intervention ($p > .05$). Finally, no relationship was found between balance and strength during pre or posttesting which contradicts the notion that strength gains are associated with balance in these participants with intellectual disabilities. In summary, the intervention length was targeted as too short to achieve the desired strength changes.

Chapter 1

INTRODUCTION

Adults with intellectual disabilities have higher incidence of falls with some estimates placing fall risks at 34 %. This value is consistent with older adults from the general population and supports the notion that adults with intellectual disabilities may experience balance deficits typically associated with age related declines found in the general population (Cox, Stancliffe, Durvasula, & Sherrington, 2010). Inactivity is a potential rationale for age related declines that begin at a very young age for individuals with intellectual disabilities and may contribute to other motor deficits noted in the motor area for the target population.

Strength and conditioning training is a potential avenue to improve independent functioning as well as positively impact health and wellness for adults (Uher, Svedova, Brtkova, & Junger, 2010). The principles recommended by the National Association for Strength and Conditioning include core lifts with multiple sets and low repetitions using loads at or exceeding 85% of an individual's one repetition max have been studied in the general population (Baechie, Earle, & Wathen, 2008). What is lacking is the application of these principles to persons with intellectual disabilities who are interested in both functional gains related to independence but also sport specific changes in powerlifting totals. Powerlifting continues to be a very popular Special Olympic sport that has generated impressive records demonstrating the potential for athletes with proper training to squat well over 500 pounds. The potential for this type of lifting to impact on neural mechanisms in lifters and impact other neurological factors such as balance is tenable, based on studies of older populations (Bird, Hell, Ball, & Andrews, 2009).

Powerlifting is a sport in the Special Olympics and for this reason the use of a more intensive lifting program has the potential to be both a therapeutic intervention and intrinsically motivating to individuals with intellectual disabilities. Furthermore, given the availability of strength and conditioning equipment, powerlifting is a viable family centered activity. The target population for the current study includes adults with mild to moderate intellectual disabilities.

Statement of the Problem

The purpose of this study was to determine the effects of a core-lifting program on functional balance skills in adults with intellectual disabilities. This study also looked to compare balance results for the target group to a group of typically developing young adults participating in the same protocol. Furthermore, this study looked to develop a core lifting task analysis for leisure time and competitive lifters with intellectual disabilities. The following research questions were studied:

1. Is there a relationship between strength changes and improvements in balance in a group of individuals with intellectual disabilities following a progressive powerlifting program?
2. Are there group differences in balance following a core lifting program between individuals with intellectual disabilities and typically developing peers?
3. What are the strength changes following a six week progressive powerlifting program in lifters with intellectual disabilities?
4. What is the relationship between level of independence during a squatting task and balance in persons with intellectual disabilities?

Hypotheses

This study was designed to test the following research hypotheses:

1. It is hypothesized that balance will be related to strength gains in participants following intervention.

2. It is hypothesized that there will be group differences in balance following a core lifting program between individuals with intellectual disabilities and typically developing peers.
3. It is hypothesized that there will be an increase in strength as measured by rate of force development following the six week progressive overload powerlifting program.
4. It is hypothesized that as balance increases, the level of independence during a squatting task will increase in persons with intellectual disabilities.

Operational Definitions

There are some important terms that pertain specifically to this study. These include the following constitutive and operational definitions.

Intellectual Disabilities. A disability characterized by significant limitations in both intellectual functioning and in adaptive behavior that covers many everyday social and practical skills. This disability originates before the age of 18 (American Association on intellectual and developmental disabilities, 2013).

Balance. This is defined as the ability to maintain an upright posture during both static and dynamic tasks (Benjuya, Melzer, & Kaplanski, 2004). In this study, balance was determined using the Berg Balance scale, BESS balance protocol, and force plate analysis.

***Strength*.** The National Strength and Conditioning Association defines strength as the ability of a muscle or muscle group to exert maximal force. Strength was measured using the Ariel Computerized Exercise System (ACES).

Core Lifting Program. Is defined as any weight bearing activity that requires the use of multiple muscles and balance (Baechle & Earle, 2008). In this study, the core lifts used were the bench press, the squat, and the deadlift.

Young Adult. Is defined as anyone with the chronological age between 18 and 45.

Delimitations

This study is delimited to the following:

- Participants were young adults with and without intellectual disabilities between the ages of 25-45.
- Participants included males who have intellectual disabilities who are independent in their ambulation and do not use either a walker or a wheel chair.

Assumptions

There were several assumptions under which this research was performed:

- It was assumed that participants in the treatment group would only be participating in the core lifting program and would not be taking part in any outside resistance training or exercise program while the study was going on.

- All participants tried their hardest during all testing sessions.

Limitations

There are several limitations that are known to exist:

- Due to the nature of this population, a non-probability sample was used.
- The participants only lifted one day per week.
- This study used core lifts (squat, bench press, and deadlift) from the Special Olympics International coach's manual (2011).
- The comparison participants were not matched on age or gender to the target sample.

Significance of the Problem

Poor balance and falls are a problem for many segments of the population, including individuals with intellectual disabilities (Piirtola, & Era, 2006). Further, adaptations to resistance training protocols include neurological changes that may improve sport specific performance as well as improve balance in populations at risks for falls (Bird, Hill, Ball, & Williams, 2009). However, there is little information on the effects of a resistance-training program with regard to balance in young adults with intellectual disabilities. Improving functional skills in individuals with disabilities is often neglected in many transition programs, therefore not preparing them for many employment opportunities that require manual labor (Smail & Horvat, 2009). In a study that looked to categorize parents' priorities for participation of children and youth with cerebral palsy, the most frequent priority for all children was activities of daily living (Chiarello, Palisano, Maggs, Orlin, Almasri, et al., 2010). Strength training has been shown to improve the major components associated with independent functioning in later years (Uher, Svedova, Brtkova, & Junger, 2010).

The use of a functional training program in young Special Olympic athletes has been shown to impact positively on the physical capacity and functional ability consistent with other forms of exercise training (Barwick, Tillman, Stopka, Dipnarine, Delisle, et al., 2012). The use of a community-based resistance program has led to improvements in balance performance, decreased sway velocity, and a significant increase in lower limb strength (Bird, Hill, Ball, & Williams, 2009).

Summary

The use of resistance training protocols on young adults with intellectual disabilities is a topic in need of more study. Resistance training is a common free time activity for both adults and adolescents and, further, powerlifting is a sport included in Special Olympics formats around the world. Powerlifting can provide young adults with intellectual disabilities an excellent lifetime activity allowing them to set performance goals and reach them. Strength and conditioning protocols can also be used to improve functional skill capacity in young adults with intellectual disabilities leading to a decrease in fall rates among this population. If a relationship exists between resistance training and improving functional capacity in young adults with intellectual disabilities, this population can see an improvement in health and fitness and more importantly, an improved quality of life for themselves and their families.

Chapter 2

Review of Related Literature

The review of literature includes research findings related to intellectual disabilities, strength and balance, and strength gains as they related to neurological adaptations.

Intellectual Disabilities

Persons with intellectual disabilities (ID) experience a high incidence of falls and subsequent injuries. Cox, Clemson, Stancliffe, Durvasula, and Sherrington (2010) place fall risks at 34 % for adolescents and adults with intellectual disabilities and this is consistent with older adults from the general population. This increased risk of falls can lead to inactivity and dependence on caregivers if persons with intellectual disabilities are unable to safely ambulate in the community. Inactivity is a potential reason for motor deficits and age related declines that begin at a very young age for individuals with intellectual disabilities. Kozub (2003) indicates that adolescents with intellectual disabilities are prone to inactivity and a steeper age related decline in physical activity compared to peers without disabilities. It has long been asserted that strength and conditioning impacts on factors related to functional capacities in athletes, older adults, persons recovering from injuries, and persons with disabilities.

Strength and Balance

The theoretical framework for the proposed project utilizes dynamic systems theory with attention being paid to outcomes that are related to all three levels of constraints. Specifically, individual structural constraints related to strength and balance, which directly impact on functional constraints (Figure 1). Furthermore, the influences that come from the family as a function of changes in individual structural constraints impact on cohesion and mobility of the family within the environment as a result of decreased falls. These, in turn, are believed to impact physical activity behavior in persons with intellectual disabilities consistent with the model proposed by Kozub and Frey (2006).

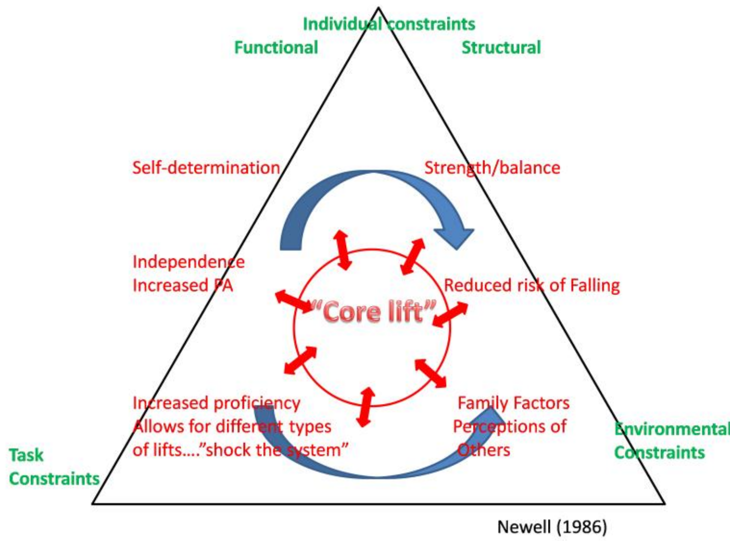


Figure 1. Projected outcomes utilizing Newell's constraint model.

Newell's (1986) model identifies strength as an individual structural constraint. Strength and coordination are required for the body to adapt to changes in the environment and maintain control and posture in order to avoid falling. Gait disturbances related to joint laxity and an inability to adapt in situations where stability is required make some individuals with intellectual disabilities at risk for increased falls (Agiovlasitis, McCubbin, Yun, Mpitsos, & Pavol, 2009; Smith, Ashton-Miller, & Ulrich, 2010). For persons with intellectual disabilities, balance deficits are noted throughout the lifespan and the onset of decline is much earlier than for non-disabled peers. Specifically, persons with Down Syndrome display balance deficits and declines consistent with that of much older adults who are prone to falls (Smith & Ulrich, 2008).

With respect to age related declines, muscle weakness in the legs is likely in typically developing populations. However, these age related declines in balance are characteristic of persons with intellectual disabilities at a younger age and may be positively impacted by proper physical activity programing during adulthood (Bird, Hill, Ball, & Andrews, 2009). Age related strength declines impact on walking and balance in the elderly and generalizing these changes to persons with intellectual disabilities has been the target of several data based studies (Smith et al., 2010; Smith & Ulrich, 2008). Furthermore, age related declines are a factor that interacts with motivation, mobility, and restricted access to community physical activity in persons with intellectual disabilities (Carmeli, Kessel, Coleman, & Ayalon, 2002). These balance decrements are a major area of concern for program providers in order to avoid accidents and injuries (Jankowicz-Szymanska, Mikolojczyk, & Wojtanowski, 2012).

In Figure 1, environmental constraints are those factors that may impact on motor behavior and physical activity levels (Newell, 1986). These can be related to family, home, and community opportunities and other socio-cultural constraints related to how society views physical activity for persons with intellectual disabilities. In the case of resistance training, it is not uncommon for fitness facilities to discourage the participation of persons with intellectual disabilities in their gyms due to fear of injury and an inability of trainers to work with the target population for this study. Finally, task constraints refer to changes in the progressive resistance programs as well as the ability to impact on strength related performances that are a direct result of a successful intervention (Newell, 1986).

Strength Gains and Neurological Adaptations

For the current study, it is important to note that declines in balance and locomotor function are part of the normal aging process in humans. Furthermore, these declines noted in persons with intellectual disabilities appear to occur at a much earlier age than the general population (Carmeli, Bar-Yossef, Ariav, Paz, Sabbag, & Levy, 2008). Smith and Ulrich (2008) demonstrated that adults with Down syndrome walked more slowly and demonstrated stabilizing strategies associated with inefficient and high risk patterns that call for interventions to increase stability. Strength and conditioning is one such intervention and specifically Shields and Taylor (2010) found that changes in lower limb performance are possible in persons with intellectual disabilities.

Physical activity, as an intervention for balance deficits noted in people with intellectual disabilities is present in the literature. Furthermore, long-term resistance training has been tied to appropriate adaptations by the central nervous system in the general population (del Olma, Reimunde, Viana, Acero, & Cudeiro, 2006). The use of resistance training as an intervention for persons with disabilities is supported where strength gains and increases in functional skills are possible with specific training protocols (Eek & Beckung, 2008; Fimland, Helgerud, Guber, Leiveth, & Hoff, 2010).

In general, physical activity is an intervention that is used to facilitate more stability and balance, and general increases in recruitment of motor units in typically developing humans (Carroll, Selvanayagam, Riek, & Semmier, 2011). Furthermore, stability and balance can be enhanced by a program of activities provided to learners with intellectual disabilities using gymnastics (Fotiadou, Neofotistou, Sidiropoulou, Tsimaras, Mandroukas, & Angelopoulou, 2009), dance programming (Tsimaras, Giamouridou, Koraridas, Sidiropouou, & Patsiaouras, 2012), and treadmill walking (Carmeli et al., 2002). What is of consequence for the treadmill programming afforded in Carmeli, is that these gains were related to an older sample of persons with intellectual disabilities showing the potential for exercise to impact on balance and strength across the lifespan. Finally, Shields and Taylor (2010) demonstrated gains in strength as a result of a 10 week progressive resistance program using machines for both lower and upper body. This is important, however it leaves a void in the literature related to the effect of progressive resistance training using "core lifting" principles. Core lifting refers to multiple joint and lifts where large muscle areas are recruited (Baechle & Earle, 2008). Baechle and Earle provide a rationale for why free weights lifted using techniques that require balance are more sport specific and therefore have the potential for not only strength gains, but for the neural adaptations of interest in the current proposal.

Strength and conditioning professionals have known for years about the importance of specificity of training or making sure that the strength and conditioning activities selected mirror the athlete's target sport (Baehchle & Earle, 2008). These concepts generalize to the physical therapy program provider who is interested in remediation for limitations that are a function of some condition or injury (Taylor, Dodd, & Damiano, 2005). The current study takes this concept even further in looking at functional gains and specificity training using the squat which is part of Special Olympics training and competitions (Special Olympics, 2011). This competitive lift has the potential to impact on many body systems since it is multi-joint, uses multiple large muscle groups, and is related to an enjoyable lifetime sport requiring equipment that can be found in most stores and fitness facilities. Furthermore, there is a functional component in daily living with respect to the squat which is the motion used to sit, stand, and in some cases perform a work related task.

Studies examining the use of progressive resistance for upper and lower body exist in the published literature. Most notably, Shields et al. (2008) examined the effect of training two times per week using machines over a 10 week period and found both strength gains and improvement in functional skills. However, gains in functional skills did not mirror gains in strength in this sample. The use of machines may have limited the outcome, given the lack of balance needed to execute a lower body resistance exercise as compared to a multi joint, weight bearing, and core lift such as the squat (Baechle & Earle, 2008). Free weights, in general, increase the skill demands in lifting and are unexplored using core lifts in the published research literature, although sources advocate for these training protocols in persons with intellectual disabilities (Special Olympics, 2011). An additional void exists in the literature examining the strength of using free weights, multi joint, large muscle mass, and core lifting to examine subsequent balance changes following this more extreme lifting protocol. Feasibility is established through Special Olympics Coach's Guide (2011) and for more severe disabilities, fitness related activities are possible if task analysis principles are utilized. Physical activity specific task analysis recommendations are found in Project TRANSITION (Jansma, Decker, Ersing, & McCubbin, 1988). Jansma (1999) recommends a task analysis system with multiple scoring systems including performance and levels of independence. The current project uses this system with a specific task analysis of the target squatting lift.

Summary

Physical interventions using therapeutic models demonstrate improvements in fall related attributes such as balance, when adults with intellectual disabilities train (Jankowicz-Szymanska, Mikolajczyk, & Wjtanowski, 2012). Sport related training, such as powerlifting, is a vehicle for full inclusion given the popularity of this lifetimes sport across the US and worldwide. The community engagement can range from participation in the local gym to world events that are put on for both athletes with disabilities and the general population. Furthermore, integrated participation with such organizations as USA Powerlifting is encouraged for those athletes who have the prerequisite skill to complete the squat, bench, and deadlift (all three are part of Special Olympics powerlifting). In general, the popularity of weight lifting is unquestionable. Furthermore, this activity has been deemed a safe intervention for individuals who have a wide range of disability or health concerns (Shields, Nicholas, Taylor, Dodd, 2208). Employment opportunities are enhanced if individuals with intellectual disabilities are more able to safely navigate the communities outside of homes and in the workplace. Independent living is inherent in any intervention that increases strength and balance. The current project examines the use of progressive resistance principles to improve balance, strength, and physical activity. Findings have the potential to generalize to other target populations if improvements in balance are achieved and physical activity increases.

Chapter 3

METHODOLOGY

This study addressed the research questions pertaining to group differences in balance between individuals with intellectual disabilities following a progressive overload powerlifting program. This study utilized a non-equivalent control group design and examined four research hypotheses. Following data collection, these data were then analyzed in relation to the following null hypotheses related to: (1) improvements in balance from pretest to posttest in individuals who take part in the six week progressive powerlifting program, (2) group differences in balance following a core lifting program, (3) increases in rate of force development following the six week progressive overload powerlifting program, and (4) the relationships between balance and the level of independence during a squatting task in persons with intellectual disabilities.

Participants

The sample for this study included eight male adolescents and adults between the ages of 27 to 43 who met the criteria of having an intellectual disability defined by the American Association on Intellectual and Developmental Disabilities (2013) as a disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability must originate before the age of 18. An additional 10 participants without disabilities were used as a comparison group for study findings. These participants ranged in age from 21 to 27 years of age. Inclusion criteria for participants with intellectual disabilities consisted of volunteers from a local adult and adolescent agency responsible for independent living in the large northeastern city. All participants were given permission via a signed consent from a caregiver or parent responsible for the care of the individual. Furthermore, only participants who ambulated without assistance of either a walker or wheel chair were included in the study. The comparison group were volunteers enrolled in a small college in the northeast. All participants completed an informed consent as per institutional review board policies at the college. Table 1 contains additional participant demographic information related to the two study groups.

Table 1

Demographics of Participants for Sample (*N*=18)

		Disability Group (*N* = 8)	**Non-Disabled (*N* = 10**)**
Gender			
	Male	8	9
	Female	0	1
Age			
	Mean	35.38	22.30
	SD	5.553	1.829
Height			
	Mean	65.25	68.10
	SD	3.955	2.378
Intelligence			
Scores*	Mean	61.33	
	SD	4.726	

Note. For intelligence scores, only 3 participant scores were available*. Further, two participants dropped out of the study before completing the posttesting**.

Procedures

For the sample group, informed consent was secured from the recreation director, agency director, and parents before data was collected. Parental consent and agency personnel consent was obtained by contacting potential participant families using the telephone. Two different informed consent letters were used. One informed consent for parents or caregivers of persons who wished to take part in the study (Appendix A). Second, an ascent document was read to participants and was signed by participants who agreed to take part (Appendix B). Study details were written in the parental consent and were read to potential participants from the ascent document. Both informed documents stated what the study entailed, background information, procedures for how the study was to be performed, permission to use any results or findings, steps for maintaining confidentiality of participants, and any possible safety concerns. Also, it stated that participants can choose to withdraw from the study at any time. Following consent, three main study activities occurred. These included a pretesting session, lifting/intervention, and a posttesting session.

Informed consent was also secured for the comparison group. The informed consent documents for the comparison, non-disabled group stated what the study entailed, background information, procedures for how the study was to be performed, permission to use any results or findings from the study, steps for maintaining confidentiality of participants, and any possible safety concerns. This consent also stated that participants were able to withdraw from the study at any time (Appendix A).

Instrumentation

Balance was assessed using the Berg Balance Scale (Appendix C); BESS balance protocol (Appendix D), and a force plate (Appendix E). A Task analysis of the squat (Appendix F) was used to assess lifting skill of the participants. Strength was assessed using the Ariel Computerized Exercise System (ACES) to determine rate of force development of the participants (Appendix G).

Berg Balance Scale

The Berg Balance Scale (Appendix C) is a 14-item scale designed to measure balance of the older adult in a clinical setting. The Berg is considered the gold standard assessment of balance for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research.

Equipment for the Berg Balance Scale includes a ruler, two standard chairs (one with arm rests, one without) footstool or step, and a stopwatch or wristwatch with a timing function. The Berg Balance Scale is scored using a 5-point scale ranging from 0-4. A score of “0” indicates the lowest level of function and a score of “4” indicates the highest level of function; a total score of 56 can be obtained. A score ranging from 41-56 equals a low fall risk, 21-40 equals a medium fall risk, and 0-20 equals a high fall risk. For most items on the scale, the subject is asked to maintain a given position for a specific time. More points are deducted progressively if the time or distance requirements are not met, the subject's performance warrants supervision, and/or the subject touches an external support or receives assistance from the examiner. Subjects will be told that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. A score was recorded for each of the 14 test items and a total score was obtained. Spotters were positioned on both sides for all balance tests to ensure that participants did not fall. Participants performing The Berg Balance Scale were videotaped and participants were scored afterward by the researcher.

BESS Balance Protocol

The BESS balance protocol (Appendix D) is a system designed to test functional balance. It is a test where participants are asked to first stand on a firm surface with their eyes closed with hands on their hips while performing three different static positions: two feet together, standing on their non-dominant foot, and a tandem stance. Participants are then asked to perform the same three static positions while standing on a foam, Airex pad (Appendix H). Scores were calculated by how many times the participant had to open their eyes, lift hands off their iliac crest, step, stumble, or fall, move hip into greater than 30 degrees abduction, lift forefoot or heel, and/or remain out of the test position for greater than five seconds. Each test lasted 20 seconds with three trials performed by each participant. Participants were recorded performing the test using video cameras and were scored by the researcher. Observer agreement was obtained using a second scorer, whose scores were compared to the principle investigator. The reliability of the BESS ranges from moderate (<0.75) to good (>0.75) with moderate to high criterion-related validity (single-leg foam: r=.79, tandem-foam: r=.64, single-leg firm: r=.42, double leg foam, r=.31) (Bell, Guskiewicz, Clark, & Padua, 2011).

Each of the 20 second trials was scored by counting the errors, or deviations from the proper stance, demonstrated by the subject. The examiner only began counting errors after the individual has assumed the proper testing position. The maximum total number of errors a subject can commit for any single condition is 10. If a subject commits multiple errors simultaneously, only one error is recorded. Subjects that are unable to maintain the testing procedure for a minimum of five seconds were assigned the highest possible score of ten for that testing condition. The scores from each testing situation (firm surface and foam surface) were added together to receive a BESS total score for that trial. The average of the three trials were taken as recommended by Broglio, Zhu, Sopiarz, and Park (2009).

Force Plate

Force plates (Appendix E) were used to measure the path from the center of pressure of each participant. Each participant performed three different static positions with their eyes closed and hands on their hips for 10 seconds while standing on the force plate. The positions consisted of two feet together, standing on their non-dominant foot, and a tandem stance. Participants also performed one repetition of a squat holding a two kilogram medicine ball while standing on the force place.

Squat Task Analysis

A squat task analysis (Appendix F) was used to assess lifting ability and level of prompting necessary to complete the squat. The task analysis consists of 12 steps, with each step being scored based on the level of prompt required for the subject to perform that step successfully. This task analysis developed for the current study include information found in Jansma (1999) in the federally funded project TRANSITION (Jansma et al., 1988) aimed at creating procedures for teaching fitness and hygiene to persons with serious disabilities. The scoring key for the task analysis is as follows: unobserved (UO) meaning the subject did not attempt (0 points), high physical+ consisting of constant physical prompt in addition to verbal prompting with modeling (1 point), minimal physical+ this means the step was physical to initiate in addition to verbal with modeling (2 points), high verbal/modeling consists of verbal and modeling required to get the subject to perform the step successfully (3 points), minimal verbal meaning verbal direction throughout steps (4 points), a score of independence consists of verbal direction to initiate (5 points), and total independence consist of the subject self-initiating the skill. A score of total independence is not to be considered in scoring. The scores of each step were added to get a sub-total for each level of prompt and the percent task score, average individual score, weight used, and reps/performance score were calculated and recorded. Participants were videotaped performing the squat task analysis and were scored after by the researcher.

Ariel Computerized Exercise System (ACES)

The ACES lifting machine (Appendix G) was used to assess squat and bench press rate of force development. ACES is well suited for sports medicine, medical diagnostics, physical therapy, rehabilitation, fitness training and biomechanical research (Tullman Human Performance Systems, 2011). Developed by Ariel, the ACES automatically monitors, controls and modifies resistance and velocity, in “real-time” as the exercise is performed. The system is constantly self-adjusting to each individual’s capabilities and limitations, and may be used in isotonic, isometric, and isokinetic modes or in combination (Tullman Human Performance Systems, 2011). The ACES machine is capable of recording accurate measurements of movement, strength, endurance, and has the capacity for storing this data for subsequent comparison of the individual's performance.

Participants performed two different types of sets for both the squat and the bench press using the ACES machine (Appendix G); a speed set and a force set. Speed sets were done for six repetitions with the only resistance being the weight of the lever arm. Participants were instructed to move as fast as they could for six repetitions in both the squat and the bench press. Force sets were performed for three repetitions with the participants being instructed to push as hard as they could against the lever arm for three repetitions. Rate of force development for each participant was calculated by the ACES machine and collected for analysis. The ACES machine has a reliability estimate of 0.44 (bench press) to 0.91 (bench pull and leg extension flexion) and a validity estimate ranging from -0.02 to 0.23 (Jablonowsky, Inbar, Rotstein, & Tenenbaum, 1992).

Data Collection

Data were collected throughout the study. These included pretesting, a functional squat during intervention days, and posttesting. During the study, a warm-up and cool down protocol were used consistent with the Special Olympics Powerlifting Coaching Guide (2011). Following the intervention, a posttesting data collection finalized study activities.

Pretest. Pretest data collect took place over two days during the first two weeks of the study. Each participant in the study was randomly assigned an order for which they were to perform each of the tests. Balance tests consisted of the Berg Balance Scale (Appendix C), BESS balance protocol (Appendix D), force plate analysis as well as force plate estimates of balance for the functional squat (Appendix E), and the squat task analysis (Appendix F). The test of strength consisted of the ACES machine (Appendix G), which participant's rate of force development was determined.

Warm-Up Protocol. The powerlifting intervention took place once a week for six weeks. Each training session began with the participants performing a warm-up as well as one repetition of the medicine ball squat while standing on the force plate. The medicine ball squat on the force plate was used to analyze the path from the center of pressure from week to week during the powerlifting intervention. This warm-up followed the National Strength and Conditioning Association (NSCA, 2008) and SOI (SOI, 2011) guidelines. A general warm-up was performed first and this occurred when the athlete performed major muscle group movements not associated with the activity about to be done, this took the form of jogging two to five laps around a standard gymnasium. After the general warm-up, participants then worked on their flexibility by performing stretching exercises. They began with an easy stretch to the point of tension, and held this position for 15-30 seconds until the pull lessened. When the tension eased, they slowly moved further into the stretch until tension was again felt. This new position was held for an additional 15 seconds. Each stretch was repeated two to four times on each side of the body. Upper body stretches consisted of the chest stretch, side stretch, arm circles, neck stretch, and shoulder stretch. Lower body stretches consisted of the standing quad stretch, forward bend, and the calf stretch. Lower back stretches that were performed are the side straddle stretch, hurdle stretch, and the hip stretch. The importance of a warm-up is that it prepares the muscles, nervous system, tendons, ligaments, and cardiovascular system by raising the body temperature. The warm-up helps prepare the athlete mentally by beginning the concentration necessary to complete the exercise routine or weight training workout. The warm-up also reduces injury, since warm muscles and their connectors are more flexible and easily stretched (SOI, 2011).

Powerlifting Intervention. Once the warm-up was complete, participants were brought into the weight room to perform the powerlifting intervention. For the intervention or powerlifting training, the lifting protocol followed the Special Olympics Coaching Guide (2011) and was used to dictate proper squat, bench, and deadlifting technique. Each lift is broken down into a task analysis format and includes both safe lifting procedures and proper form for competitive lifters competing under the Special Olympics format (Jansma, Decker, Ersing, McCubbin, & Combs, 1988). As recommended, a squat cage was used. All lifting occurred in the athletics weight room of a small northeastern public college under the supervision of the researcher (who is a certified strength and conditioning specialist) and the strength and conditioning coach. The squat cage allowed for a safe core lifting program to be performed. Three spotters were used for the squat and bench (one on each side of the barbell and one behind the bencher or squatter) for safety. Spotting for the deadlift included standing behind the lifter to ensure he or she did not fall back after setting the weight down. These spotters were volunteers from the College. Each participant was given their own squat cage with the height of squat cage being adjusted based on the participant's height as well as safety pins put in place based on the participant's height in order to ensure the safety of each participant as well.

Participants performed three sets in the bench press, squat, and deadlift with loads for lifting being calculated based on the amount of weight that could be lifted for six to eight repetitions. This included a 60-90 second rest in between sets (NSCA, 2008; SOI, 2011). Weights used and number of repetitions performed were recorded each week on the participant's individual data recording sheet (Appendix J). To ensure accuracy of the recording process, volunteers from the college helped the participants record the weight and number of repetitions used each week. Weight was increased every two weeks. The frequency, duration, and intensity of the program met the NSCA guidelines for participants with intellectual disabilities (NSCA, 2008). After participants performed three sets of six-eight repetitions of the bench press, squat, and deadlift, participants performed one assistance exercise for the triceps, latissimus dorsi, hamstrings and abdominals. Assistance exercises consisted of two to three sets of 10-12 repetitions. Weights and repetitions for assistance exercises were also recorded on each participant's individual data sheet (Appendix J) by a volunteer from the college.

Cool Down Protocol. Once the lifting program was complete, the participants performed the Special Olympics Powerlifting Coaching Guide (2011) cool down protocol. The cool down consisted of a five minute slow aerobic jog, which helped lower the body's temperature and gradually lower heart rate. Five minutes of light stretching was also done during the cool down; this helped remove waste from the muscles. The stretches performed during the cool down are the same stretches recommended by the Special Olympics Powerlifting Coaches Guide (2011) warm-up.

Posttest Data Collection. Once the six weeks of intervention was complete, the last week consisted of posttest data collection. Posttest data collection was one day and followed the same protocol used while collecting pretest data. Each participant was randomly assigned an order which they needed to follow during the posttest procedure. Posttest data was collected on participants and consisted of the Berg Balance Scale (Appendix C), BESS balance protocol (Appendix D), force plate analysis (Appendix E), the squat task analysis (Appendix F) and the ACES machine (Appendix G). These procedures were consistent with the pretest procedures explained above.

Participants were once again videotaped while performing the BESS balance protocol, Berg Balance Scale, and squat task analysis. Videotapes were reviewed by the researcher and scored after.

Data Analysis

Data were analyzed by first examining frequency counts and other descriptive statistics for each variable. Pearson correlation was used to examine if balance was related to strength following intervention using a progressive powerlifting program. Further, Spearman correlation was used to examine the relationship between level of independence as operationalized by the task analysis scoring system (posttest) in relationship to week eight functional balance scores, force plate estimates of balance, and BESS mean values following intervention. Analysis of variance was used to address the second research question related to differences in balance following intervention. Further, following examination of assumptions, a repeated measures analysis of covariance followed to compare groups on pre and posttest changes in balance and strength consistent with the recommendations of Hair, Anderson, Tatham, and Black (1995) was conducted. All analyses were completed using SPSS 14.00 (2010).

Summary

The methods described in this chapter helped the researcher explore the research questions of interest and examine the null hypotheses. These include findings related to balance and strength differences between the target sample and a comparison group. Further, the notion that strength gains have the potential to impact on balance deficits in persons with intellectual disabilities were examined. The results and discussion section follow to determine if treatment main affects occurred following intervention.

Chapter 4

RESULTS AND DISCUSSION

The following section is organized in relation to answering the following research hypotheses. (1) Individuals who take part in the six week progressive powerlifting program will improve in balance and strength from pretest to posttest, (2) there will be group differences in balance following a core lifting program, (3) there will be an increase in rate of force development following the six week progressive overload powerlifting program, and (4) that as balance increases, the level of independence during a squatting task will increase in persons with intellectual disabilities.

Results

Initial descriptive statistics that demonstrate the status of strength in both the experimental and comparison groups is presented. This is followed by a discussion of the relationship between strength changes and improvements in balance, group differences in balance between study groups, strength changes in lifters with intellectual disabilities, and the relationship between level of independence and balance.

Descriptive Statistics

Table 2 below provides descriptive statistics for estimates of balance for both the pre and posttests. Scores are presented below for both the group with intellectual disabilities and the non-disabled comparison group. Force plates were used to measure the path from the center of pressure while participants tried to maintain their balance holding three different static positions (2 feet, 1 foot, and tandem). This was examined by charting the participant's path of the center of pressure. Those who adjusted less were better able to maintain their balance in the three static positions. To measure functional balance in the participants, the BESS system was used. Table 2 gives descriptive statistics for each individual trial as well as an overall BESS mean score. The lower the score, the less number of errors the individuals with intellectual disabilities and the participants in the comparison group made while trying to maintain their balance in the three static positions. Table 2 shows that there were no improvements in balance from pretest to posttest in any of the balance estimates used.

Table 2

Descriptive Statistics for Balance Estimates for Sample (*N* = 18)

	Group with Intellectual Disabilities		**Non-Disabled**	
Force Plate 2 Feet	**Pre Test (*N* = 8)**	**Posttest (*N* = 8)**	**Pre Test (*N* = 10)**	**Posttest (*N* = 8)***
Mean	108.93 in.	176.60 in.	95.10 in.	143.42 in.
Minimum	64.53 in.	89.02 in.	63.47 in.	.01 in.
Maximum	146.32 in.	233.28 in.	121.92 in.	246.87 in.
SD	26.93 in.	49.79 in.	17.89 in.	83.91 in.
Force Plate 1 Foot				
Mean	205.69 in.	242.80 in.	127.15 in.	190.02 in.
Minimum	155.94 in.	158.01 in.	91.15 in.	112.33 in.
Maximum	288.62 in.	394.31 in.	166.87 in.	264.93 in.
SD	41.73 in.	74.79 in.	23.54 in.	48.87 in.
Force Plate Tandem				
Mean	172.74 in.	215.46 in.	118.09 in.	199.55 in.
Minimum	142.39 in.	106.24 in.	85.58 in.	124.00 in.
Maximum	253.33 in.	296.17 in.	163.58 in.	247.52 in.
SD	35.85 in.	60.56 in.	22.53 in.	41.96 in.

BESS Trial 1				
Mean	16.63 errors	20.38 errors	14.60 errors	11.80 errors
Minimum	12.00 errors	17.00 errors	11.00 errors	.00 errors
Maximum	22.00 errors	32.00 errors	20.00 errors	23.00 errors
SD	3.46 errors	4.93 errors	2.914 errors	8.20 errors
BESS Trial 2				
Mean	17.25 errors	19.38 errors	11.70 errors	14.25 errors
Minimum	9.00 errors	9.00 errors	5.00 errors	8.00 errors
Maximum	22.00 errors	35.00 errors	15.00 errors	21.00 errors
SD	5.52 errors	7.52 errors	3.02 errors	4.27 errors
BESS Trial 3				
Mean	17.25 errors	16.14 errors	10.50 errors	12.13 errors

Minimum	10.00 errors	8.00 errors	5.00 errors	4.00 errors
Maximum	25.00 errors	24.00 errors	21.00 errors	19.00 errors
SD	4.83 errors	5.18 errors	4.62 errors	5.19 errors
BESS Mean Score				
Mean	17.04 errors	17.33 errors	12.27 errors	13.71 errors
Minimum	11.00 errors	11.67 errors	8.00 errors	7.00 errors
Maximum	22.00 errors	21.33 errors	16.33 errors	17.67 errors
SD	3.95 errors	3.33 errors	2.54 errors	4.53 errors

Note. Two participants from the comparison group dropped out of the study prior to posttesting*.

Table 3 below gives descriptive statistics for strength estimates for both pre and posttesting. Scores are presented below for both the group with intellectual disabilities and the non-disabled comparison group. Learners were estimated to have strength ranges related to maximum force using the ACES, average rate of force development using the ACES, and maximum rate of force development using the ACES. Mean scores improved from pretest to posttest in the group with intellectual disabilities for ACES squat max force with a pretest mean of 38.44 lbs. to a posttest mean of 45.74 lbs. and ACES average rate of force development with a pretest mean of 211.87 lbs. to a posttest mean of 224.88 lbs. When it came to ACES maximum rate of force development the disability group showed a decrease in mean scores from pretest to posttest going from 286.25 lbs. to 277.00 lbs. For the non-disabled comparison group there were improvements in mean scores from pretest to posttest on all three estimates of strength.

Table 3

Descriptive Statistics for Strength Estimates for Sample (*N* = 18)

	Group with Intellectual Disabilities		**Non-Disabled**	
ACES Squat Max Force	**Pre Test (*N* = 8)**	**Posttest (*N* = 8)**	**Pre Test (*N* = 10)**	**Posttest (*N* = 8)***
Mean	38.44 lbs.	45.74 lbs.	154.14 lbs.	203.00 lbs.
Minimum	28.90 lbs.	24.00 lbs.	84.40 lbs.	.01 lbs.
Maximum	57.00 lbs.	67.80 lbs.	278.00 lbs.	505.00 lbs.
SD	9.55 lbs.	14.32 lbs.	54.56 lbs.	130.27 lbs.

ACES Average Rate of Force Development				
Mean	211.87 lbs.	224.88 lbs.	717.50 lbs.	821.50 lbs.
Minimum	120.00 lbs.	132.00 lbs.	389.00 lbs.	466.00 lbs.
Maximum	371.00 lbs.	340.00 lbs.	1093.00 lbs.	1499.00 lbs.
SD	84.82 lbs.	76.71 lbs.	212.91 lbs.	351.55 lbs.
ACES Maximum Rate of Force Development				
Mean	286.25 lbs.	277.00 lbs.	912.10 lbs.	994.38 lbs.
Minimum	148.00 lbs.	156.00 lbs.	536.00 lbs.	518.00 lbs.
Maximum	445.00 lbs.	441.00 lbs.	1441.00 lbs.	1688.00 lbs.
SD	108.90 lbs.	102.04 lbs.	261.42 lbs.	369.48 lbs.

Note. Two participants from the comparison group dropped out of the study prior to posttesting*.

Correlations between key study variable are found in Table 4. These include very high relationships between force plate 2 feet (X_1) and force plate tandem (X_3), ACES average ROFD (X_6) and ACES max ROFD (X_7), and substantial relationships between force plate 1 foot (X_2) and ACES average ROFD (X_6), force plate 1 foot (X_2) and ACES max ROFD (X_7), BESS mean (X_4), and ACES squat max force (X_5), ACES squat max force (X_5) and ACES average ROFD (X_6), and ACES squat max force (X_5) and ACES max ROFD (X_7).

Table 4

Posttest Correlations between Key Study Variables (*N* = 16)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Force Plate 2 Feet (X_1)	-----	.30	.82*	-.24	.29	-.17	-.14
Force Plate 1 Foot (X_2)		-----	.40	.14	-.34	-.52*	-.50*
Force Plate Tandem (X_3)			-----	-.04	-.03	-.26	-.23
BESS Mean (X_4)				-----	-.52*	-.41	-.39
ACES Squat Max Force (X_5)					-----	.57*	.60*
ACES Average ROFD (X_6)						-----	.98*
ACES Max ROFD (X_7)							-----

Note. These data represent the sixteen participants who completed posttesting, including all 8 participants with intellectual disabilities and 8 without disabilities.

Relationship between Strength Changes and Balance

When the group with intellectual disabilities statistics were compared to non-disabled group statistics there is no relationship $p > .05$ between posttest ACES squat max ROFD and posttest force plate 1 foot stance ($r = .48$) $p > .05$ in the disability group. However, posttest ACES squat max ROFD and posttest force plate 1 foot stance resulted in a very high relationship between the variables ($r = -.82$, $p < .05$) in the non-disabled group. No relationship has been found between strength changes and improvements in balance in individuals with intellectual disabilities following the intervention protocol. Figure 2 gives a scatter plot of the relationship between scores on the ACES with respect to maximum rate of force development compared to posttest balance on a one foot balancing task for each group.

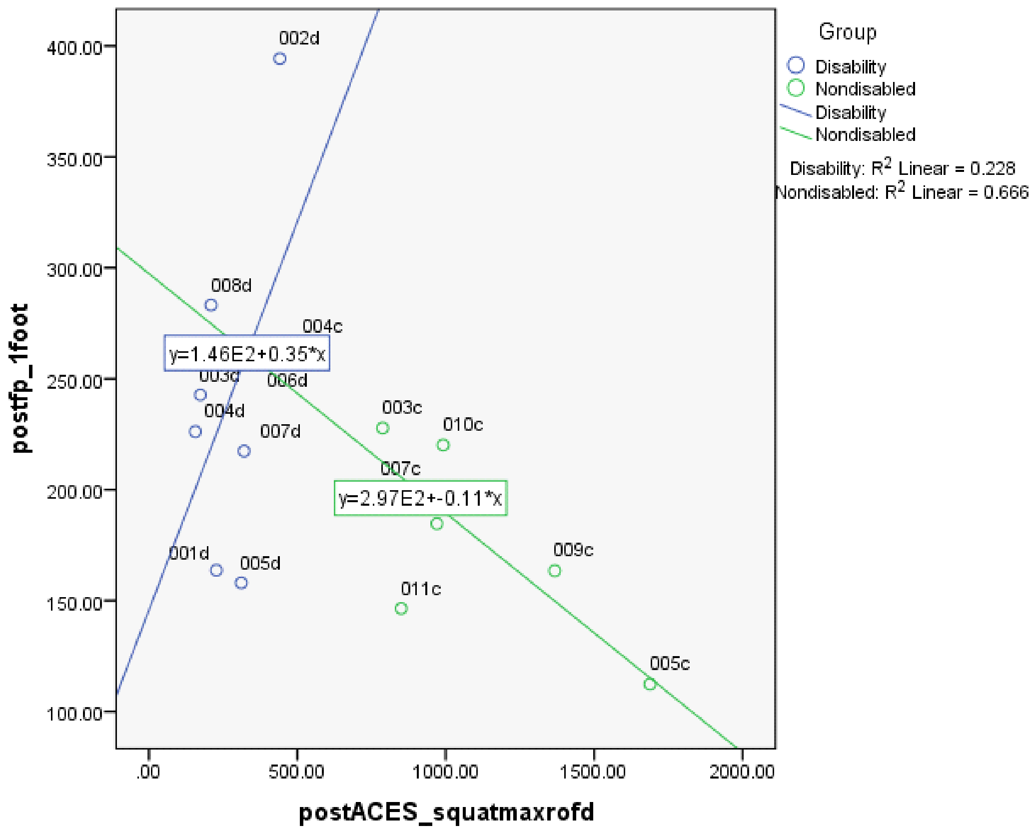


Figure 2. Scatter plot of relationship between scores on aces with respect to Rate of Force Development Maximum compared to posttest balance on one foot balancing task (*N*= 18).

Group Differences in Balance between Study Groups

Prior to examining group differences the assumptions for multivariate statistics were examined. These include a test of homogeneity of variances which resulted in satisfaction of the assumption that variances among groups were the same (Boxes *M*= 27.94, *p*> .01). Table 5 provides values relative to the multivariate repeated measures analysis of variance. These include a comparison of means from the group of lifters with intellectual disabilities in relation to a comparison group of non-disabled peers. Results indicate that the mean scores following intervention found in Tables 2 and 3 differed following training in favor of the comparison group of non-disabled peers.

Table 5

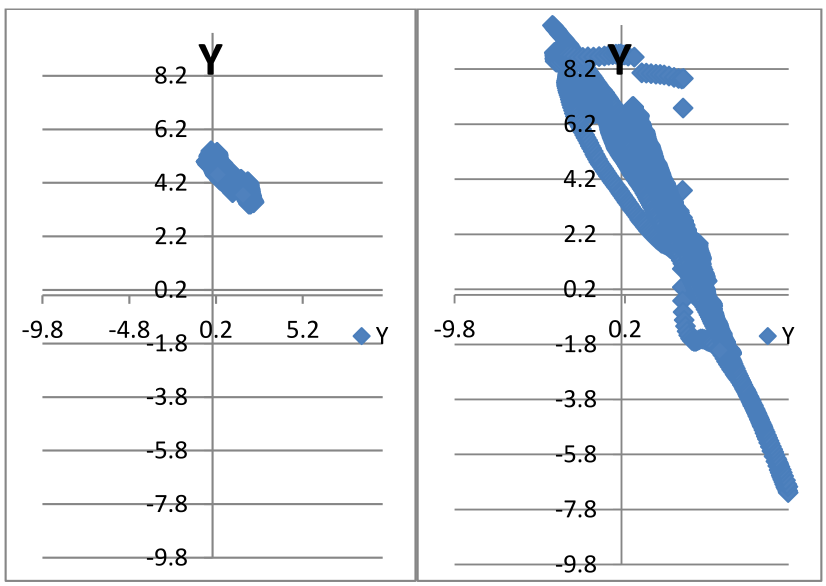
Posttest Analysis of Variance between Groups (*N*= 18)

		Sum of Squares	df	Mean Square	F	Sig.
ACES Squat Max Force	Between Groups	60489.51	1	60489.51	5.19	.037
	Total	246657.15	17			
ACES Squat Average ROFD	Between Groups	1423845.56	1	1423845.56	21.99	.000
	Total	2330130.44	15			
ACES Squat Max ROFD	Between Groups	2058507.56	1	2058507.56	28.02	.000
	Total	3087003.44	15			

Note. ROFD – Rate of force development.

Main effects were noted for posttest ACES squat max force $F(1, 17)= 5.19$, $p< .05$, posttest ACES squat average ROFD $F(1, 15)= 21.99$, $p< .05$, and posttest ACES squat max ROFD $F(1, 15)= 28.02$, $p< .05$ in favor of the non-disabled comparison group. With respect to balance, results show that balance differences did exist prior to and following the intervention, with peers without disabilities showing better balance.

Figure 3 shows balance variability among a typically developing individual (left) and an individual with an intellectual disability (right). These force plate data were taken during pretesting and indicates the path of the center of pressure among both participants. In figure 3 both participants are performing a tandem stance with their eyes closed for 10 seconds while standing on a force plate. As seen in figure 3, there is greater range of travel for the center of pressure for the participant with an intellectual disability in comparison to the person without a disability. These data support the notion that individuals with intellectual disability are experiencing balance deficits that force greater adjustments and increase the length of path for the center of pressure based on figure 3.



Individual W/O Disability Participant with ID

Figure 3. Balance variability between a typically developing individual (left) and an individual with an intellectual disability.

Strength Changes in Lifters with Intellectual Disabilities

Prior to examining the strength changes following the intervention, assumptions for multivariate statistics were examined. These include Levene's Test of Equality of Variances which resulted in satisfaction of the assumption that error variance of the dependent variable are equal across groups, $F(1,14)= 7.65$, $p > .01$. To test the strength changes in the group with intellectual disabilities following the intervention, mulivariate test were run with statistical significance found in the overall model $F(3,12)= 10.55$, $p < .01$, $Eta^2= 0.72$. Statistical significance was also found for the posttest ACES squat average rate of force development $F(1,14)= 21.99$, $p < .01$, $Eta^2= 0.61$, posttest ACES squat max force $F(1,14)= 11.51$, $p < .01$, $Eta^2= 0.45$, and posttest squat max rate of force development $F(1,14)= 28.02$, $p < .01$, $Eta^2= 0.66$.

Relationship between Level of Independence and Balance

When determining the relationship between the level of independence during a squatting task and balance, pre and posttest task analysis scores were used. Table 6 below indicates the average independence score for the group with intellectual disabilities pre and posttest.

Table 6

Pre and Posttest Task Analysis Descriptive Statistics (*N*= 8)

	Pretest Task Analysis	**Posttest Task Analysis**
Mean	68.11	89.27
Std. Deviation	30.78	14.81

Note. Task analysis scoring sheets are found in Appendix F.

Table 6 indicates an increase in the average independence score from 68.11 pretest to 89.27 posttest. This increase in the average task analysis score from pretest to posttest shows an increase in independence among the group with intellectual disabilities.

Figure 4 below shows the score of the functional balance test for the group with intellectual disabilities over the course of the study. Results indicate that the path of the center of pressure among participants declined from week one of the study to week six indicating an improvement in functional balance. From week six to the conclusion of the study there is a steady increase in the path of the center of pressure among the group with intellectual disabilities. This indicates a decrease in functional balance among the group.

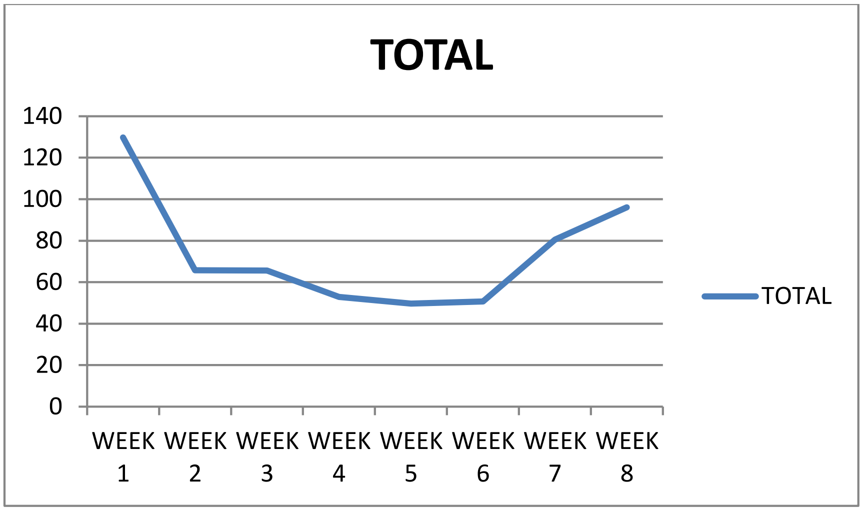


Figure 4. Changes in distance traveled in inches of center of pressure for the group with intellectual disabilities (n = 8) over the eight weeks of training.

Spearman's correlations were run to determine the relationship between the task analysis changes and week eight balance as well as other estimates of posttest balance. Table 7 below shows the results.

Table 7

Posttest Correlations between Posttest Task Analysis and Other Estimates of Posttest Balance (*N* = 16)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Task Analysis (X_1)	-----	.05	-.42	-.03	.08	-.16	.18
Functional Squat 8 (X_2)		-----	-.07	.36	.50*	.28	.32
BESS Mean (X_3)			-----	-.58	-.22	.09	.04
BERG (X_4)				-----	.27	.39	-.25
Force Plate 2 Feet (X_5)					-----	.39	.81*
Force Plate 1 foot (X_6)						-----	.53*
Force Plate Tandem (X_7)							-----

These include a very high relationship between force plate 2 feet (X_1) and force plate tandem (X_7), and a satisfactory relationship between functional squat 8 (X_2) and force plate 2 feet (X_5), and force plate 1 foot (X_6) and force plate tandem (X_7). There was no relationship between this change in the level of independence and functional squat day week eight.

Discussion

Null hypotheses related to group differences in balance following a progressive overload powerlifting program between individuals with and without intellectual disabilities are discussed in the following section. Discussion is related to the improvements in strength following a six week core lifting program and to examine if improvements in balance among both participants with intellectual disabilities and non-disabled participants occurred. This discussion will also focus on the effects of balance on the level of independence among persons with intellectual disabilities.

Strength and Balance

When examining the relationship between strength changes and improvements in balance among the group of intellectually disabled individuals, the null hypothesis was that individuals who took part in the six week progressive overload powerlifting program will not improve in balance and strength from pretest to posttest. From the above results the null could not be rejected for the group of individuals with intellectual disabilities in that there was no relationship between strength changes and improvements in balance. These results are consistent with a study by Shields et al. (2008) which concluded that although participants who trained two times per week using machines found both strength gains and improvement in functional skills, gains in functional skills did not mirror gains in strength in their sample. In the present study these findings can be attributed to the small sample size of the group.

Group Differences

When looking at group differences in balance following the core lifting program the null hypothesis was that there would be no group differences in balance following a core lifting program between individuals with intellectual disabilities and typically developing peers. Results indicate that mean scores following intervention differed and balance differences did exist prior to and after the intervention. This is consistent with the literature stating that persons with intellectual disabilities have balance deficits that are noted throughout the lifespan and the onset of age related decline is seen much earlier than their non-disabled peers (Smith & Ulrich, 2008). The non-disabled group had better balance prior to and after treatment allowing an acceptance of our original hypothesis that group differences in balance would be present between individuals with intellectual disabilities and their typically developing peers.

Strength Estimates

In order to test strength changes in the study, an Ariel Computerized Exercise System (ACES) was used. The null hypothesis was that there would not be an increase in rate of force development following the powerlifting intervention in individuals with intellectual disabilities. The measurement of maximum rate of force development was used to examine these changes because this measurement correlated in the sample to the balance estimate of the force plate one foot stance.

When examining if there were improvements in maximum rate of force development among the group with intellectual disabilities, descriptive statistics were examined. The group with intellectual disabilities actually had a decrease in mean maximum rate of force development from pretest to posttest as well as a decrease in the maximum score among the group and an increase in the minimum score among the group. This leads to a failure to reject the null hypothesis. When examining increases in strength among individuals with intellectual disabilities, results show that pre and posttest estimates are the same for both groups indicating no main effect for the model. This is inconsistent with Shields and Taylor (2010) who demonstrated gains in strength as a result from a 10 week progressive resistance program using machines for both lower and upper body training. These results once again lead us to accept the null hypothesis in that there were no changes in strength following the powerlifting intervention in the group of disabled participants. However, there is an interaction in this support for the null hypothesis or no changes. The disability group is significantly different before and after the study on balance. A main effect for balance by group is present, but nothing else.

Independence and Balance

In examining the research question involving the relationship between the level of independence during a squatting task and balance, it was hypothesized that as balance increased, the level of independence during a squatting task will increase as well in persons with intellectual disabilities. Changes for the better occurred in that the average squat task analysis score increased indicating more independence while performing a squatting task in individuals with intellectual disabilities. However, based on the results that examined the relationship between the increase in squat task analysis score and other estimates of posttest balance, no relationship was found. This leads to a failure to reject the null hypothesis.

Summary

The present study examined the effects of a progressive overload powerlifting program on balance in individuals with and without intellectual disabilities. This included the relationship between strength changes and balance, group differences in balance, changes in rate of force development and strength, and the effects that balance had on the level of independence were all examined. There were no relationships between improvements in strength and improvements in balance in the intellectually disabled group. Group differences were present in favor of that the non-disabled group who had better balance prior to and after treatment than the group with intellectual disabilities. An increase in maximum rate of force development as well as an increase in strength following the intervention was not present among the group of intellectually disabled learners. No relationship was found between the increase in independence scores among the group of intellectually disabled learners and estimates of posttest balance.

Chapter 5

RECOMMENDATIONS AND CONCLUSIONS

These data were collected to address research questions related to strength changes following a six week core lifting program and how balance was impacted in individuals with and without intellectual disabilities. In this chapter recommendations for future research are presented along with conclusions.

Future Research

The use of resistance training protocols on young adults with intellectual disabilities is a topic in need of more study. As discussed above, examining strength changes using free weights, multi joint, large muscle mass, and core lifting to examine subsequent balance changes following this more extreme lifting protocol in this population is also a topic in need of future study. Shields and Taylor (2010) demonstrate gains in strength as a result from a progressive resistance program using machines for both lower and upper body. This is important but also leaves a void related to the effect of progressive resistance training using "core lifting" principles.

The core lifts used in this study were the bench press, the squat, and the deadlift. Each of these core lifts requires the activation of multiple muscle groups as well as a high level of understanding and technique in order to be performed successfully. This posed a problem during our study especially in this population who already live very sedentary lifestyles and exhibit balance deficits. For future research, weeks prior to starting the core lifting program should be used to teach proper technique of the core lifts by not only task analyzing the squat, but the bench press and the deadlift as well. These weeks prior to the intervention should also be used to build a strong foundation and increase the general physical preparedness of the participants. This includes the addition of cardiovascular activities, which can prove to be vital in this population.

Persons with intellectual disabilities have a history of poor body composition with high body fat percentages and low muscle tone (Kozub, 2003). By adding cardiovascular exercises during this preparation period, body composition can be improved in this population prior to training. Increases in flexibility and range of motion should also be focused on during this pre-intervention period. By using the weeks prior to the core lifting program intervention to focus on task analyzing proper technique of the core lifts, build a solid foundation, improve body composition, and increase range of motion and flexibility in this population, participants will be better prepared when the intervention begins.

Another consideration for future studies involves increasing the number of times per week the participants take part in the core lifting program. Our study consisted of one training day per week. This is inconsistent with National Strength and Conditioning guidelines that recommend strength training three times per week (NSCA, 2008). Training only one day per week, even in a population that has very little experience regarding weight training, showed very little to no improvements in balance or strength after completing the intervention. Future research should focus on increasing the training days to three times per week as recommended by the NSCA, 2008 for beginners. The intervening days would allow for sufficient recovery between training sessions.

Future research needs to also focus on increasing the length of the intervention. Our intervention lasted six weeks which was only six training sessions. This was not a long enough intervention for our participants to experience any type of skeletal muscle adaptations to the anaerobic training program (NSCA, 2008). These muscular adaptations include increasing muscle size, facilitating fiber type transitions, and enhancing its biochemical and ultrastructural components (NSCA, 2008). Collectively, these changes ultimately result in enhanced muscular strength, power, and muscular endurance (NSCA, 2008). Shields and Taylor (2010) demonstrate gains in strength as a result from a 10-week progressive resistance program using machines for both lower and upper body. Muscle fiber hypertrophy appears to require a longer period of training time (>16 workouts) (NSCA, 2008), the amount of time needed to see muscle and strength gains is greater than the amount of time that our intervention took place.

Although the ACES machine was used to measure rate of force development during the pre and posttest, the participants did not take part in any training protocol using the ACES machine. The ACES system is constantly self-adjusting to each individual’s capabilities and limitations, and may be used in isotonic, isometric, and isokinetic modes or in combination (Tullman Human Performance Systems, 2011). The ACES machine is capable of recording accurate measurements of movement, strength, endurance, and has the capacity for storing this data for subsequent comparison of the individual’s performance. The ACES machine would allow for the researcher to get a more accurate indication of the participant’s effort. The use of the ACES in training is also a safer method of resistance training by allowing the researcher to monitor performance and resistance accurately. This proves to be especially important in a population where balance deficits are present and the risk of falls and injuries is high.

Conclusions

This study was designed to examine if the use of a core lifting program would lead to improvements in balance among individuals with and without intellectual disabilities. In conclusion, the current study demonstrated that group differences did exist prior to and after the core lifting intervention. More study is needed to determine if the use of a core lifting program has any impact on balance among individuals with intellectual disabilities.

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APPENDIX A

Informed Consent

APPENDIX A

The College at Brockport

Office of Kinesiology, Sport Studies, and Physical Education

STATEMENT OF INFORMED CONSENT

This form describes a research study being conducted on how progressive strength training affects balance in college aged individuals. The person conducting the research is a graduate student at The College at Brockport, SUNY in the Department of Kinesiology, P.E and Sports Studies. If you agree to participate in this study, you will be asked to perform a core-lifting program, which will include the back squat, bench, and deadlift exercises. All three lifts are part of the recommended activities of powerlifting. These are safe lifts and the researcher will ensure that all exercises are spotted properly and that loads lifted are consistent with recommendations by lifting experts. In addition to the lifting, you will be tested on balance both before and after the lifting program to help us determine effects of the lifting program. These tests include having you stand on a foam mat with eyes closed while someone counts how many times he or she has to remove their hands from the waist to maintain balance. You will also be asked to stand on a force plate while the researcher measures how well you keep your center of gravity in a small circular area measured by the instrument. Finally, you will be asked to lift using the ACES lifting machine that measures how much force the lifter is generating. The researcher will be with you at all times to observe skill in balance and record lifting results. The possible benefit from being in this study includes improved fitness, a better understanding by practitioners on how lifting affects balance in college aged individuals. Your participation in this study is completely voluntary. Your decision to take part in the study or desire to be excluded will in no way affect your grades or class standing. You are free to change your mind or stop being in the study at any time.

I understand that:

- My participation is voluntary. I have the right to refuse to answer any questions or perform any physical tasks. I will have a chance to discuss any questions about the study with the researcher after completing the activity.

- My Confidentiality will be protected and there will be no way to connect me to the written study. If any publication results from this research, I would not be identified by name. Results will be given in aggregate form. Any results used from an individual will be anonymous using pseudonyms. Neither the participants nor their schools will be identified.

- Possible risks of participating include muscle strain and/or muscle soreness may result, as with any exercise. To minimize these risks, proper technique will be emphasized, and proper spotting during exercise will be provided.

- Possible benefits of participating include improved fitness and balance.

- My participation involves performing the task of the back squat, bench press, and deadlift. These are all weight-bearing exercises that require multiple muscles and joints to perform. In addition, I will be asked to stand on two separate, stable surfaces to assess balance.

- Approximately 25 persons will take part in this study. The results will be used for the completion of a master's level thesis by the researcher.

- Data and consent forms will be kept separately in a locked filing cabinet, which will only be accessed by the investigator and faculty advisor. This data will be destroyed by shredding once the research has been completed. Electronic data will be maintained on a computer and kept separately in the faculty advisors office. The faculty advisor will lock this office at all times. Only the investigator and faculty advisor will have access to this computer and data and it will be deleted from the computer once research has been completed. Students and teachers names will be assigned identification numbers for data analysis and presentation of the results.
- Lifters will be videotaped for the sole purpose of using the videotapes to help the participant with lifting form. The videotapes will be destroyed as soon as the data are collected and observer agreement is calculated.

You are being asked whether or not you will participate in this study. If you wish to give permission to participate, and you agree with the statement below, please sign in the space provided. Remember, you may change your mind at any point and withdraw from the study with no penalty or loss of benefits.

I understand the information provided in this form and agree to participate as a participant in this project. I am 18 years of age or older. I have read and understand the above statements. All my questions about my participation in this study have been answered to my satisfaction.

If you have any questions you may contact:

Primary researcher	Faculty Advisor
Tom Rispoli	Dr. Francis Kozub
Graduate Student (516) 521-1717	Department of Kinesiology, Sports Studies, and P.E. Associate Professor (585) 395-5946
Trisp1@brockport.edu	fkozub@brockport.edu

PLEASE CIRCLE YES OR NO
I give my permission to be videotaped and understand that these videotapes will not be seen by anybody but the researcher and will be destroyed after the study is completed.

Yes / No

____ _________________________

Signature of Participant Date

Participant's name ____________________________________

APPENDIX B

Ascent Document

The College at Brockport

Office of Kinesiology, Sport Studies, and Physical Education

Statement of Assent for Observation, Interview and Videotape

(To be read to persons with Intellectual disabilities ages 16-45)

My name is Dr. Kozub. I am a teacher at The College at Brockport. I am going to take a few minutes to tell you about a study that I am working on. I want you to help me with this study. To help me I will need you to lift weights. I am asking you to do Powerlifting. In this type of lifting you train to lift as much weight as you can, using the squat, bench, and deadlift. I am also going to ask you to do some balancing games. Before you do the weightlifting, I am going to test you to see how strong you are and how well you balance. This includes asking you to balance on a blue mat and try to stand on one foot while closing your eyes. Second, I am going to ask you to do the same thing on a flat surface called a force plate. Third, you are going to stand up and sit down so I can see how well you balance yourself. Finally, I am going to ask you to push real hard on a machine that measures how strong you are. After you do these tests, we will begin to train for powerlifting. This will take 8 weeks and you will be asked to lift twice a week during the study. You are free to stop at any time in the study including the testing at the beginning or during the training. If you do not want to take part in the study, have someone call me, and I will make sure you do not have to participate anymore. I will not be mad if you decide to stop taking part in the study.

If it is okay with you for me to help you lift weights and learn more about your balance and strength, you can write your name on the first line below.

Under your name you can write today's date, which is _______________.

Name: ____

Date: _______________

Witness 18years or older: ____

APPENDIX C

Berg Balance Scale

APPENDIX C

Berg Balance Scale

The Berg Balance Scale (BBS) was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. The BBS has been evaluated in several reliability studies. *A recent study of the BBS, which was completed in Finland, indicates that a change of eight (8) BBS points is required to reveal a genuine change in function between two assessments among older people who are dependent in ADL and living in residential care facilities.*

Description:
14-item scale designed to measure balance of the older adult in a clinical setting.

Equipment needed: Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway

Completion:
Time: 15-20 minutes
Scoring: A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56

Interpretation:
41-56 = low fall risk
21-40 = medium fall risk
0 –20 = high fall risk

A change of 8 points is required to reveal a genuine change in function between 2 assessments.

Berg Balance Scale

Name: ______________________________ Date: ____________________

Location: ____________________________ Rater: ____________________

ITEM DESCRIPTION	SCORE (0-4)
Sitting to standing	________
Standing unsupported	________
Sitting unsupported	________
Standing to sitting	________
Transfers	________
Standing with eyes closed	________
Standing with feet together	________
Reaching forward with outstretched arm	________
Retrieving object from floor	________
Turning to look behind	________
Turning 360 degrees	________
Placing alternate foot on stool	________
Standing with one foot in front	________
Standing on one foot	________

Total ________

GENERAL INSTRUCTIONS

Please document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

- the time or distance requirements are not met
- the subject's performance warrants supervision
- the subject touches an external support or receives assistance from the examiner

Subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.

Berg Balance Scale

SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hand for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or stabilize
( ) 0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding on.
( ) 4 able to stand safely for 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unsupported

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
INSTRUCTIONS: Please sit with arms folded for 2 minutes.
( ) 4 able to sit safely and securely for 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

STANDING TO SITTING
INSTRUCTIONS: Please sit down.
( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assist to sit

TRANSFERS
INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cuing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.
( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays safely
( ) 0 needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER
INSTRUCTIONS: Place your feet together and stand without holding on.
( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

Berg Balance Scale continued…

REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING
INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)
( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm (5 inches)
( ) 2 can reach forward 5 cm (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION
INSTRUCTIONS: Pick up the shoe/slipper, which is in front of your feet.
( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING
INSTRUCTIONS: Turn to look directly behind you over toward the left shoulder. Repeat to the right. (Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.)
( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

TURN 360 DEGREES
INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.
( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED
INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.
( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps in > 20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

STANDING UNSUPPORTED ONE FOOT IN FRONT
INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width.)
( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

STANDING ON ONE LEG
INSTRUCTIONS: Stand on one leg as long as you can without holding on.
( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold ≥ 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently.
( ) 0 unable to try of needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)

APPENDIX D

Balance Error Scoring System (BESS)

APPENDIX D

Balance Error Scoring System (BESS)

Developed by researchers and clinicians at the University of North Carolina's Sports Medicine Research Laboratory, Chapel Hill, NC 27599-8700

The Balance Error Scoring System provides a portable, cost-effective, and objective method of assessing static postural stability. In the absence of expensive, sophisticated postural stability assessment tools, the BESS can be used to assess the effects of mild head injury on static postural stability. Information obtained from this clinical balance tool can be used to assist clinicians in making return to play decisions following mild head injury.

The BESS can be performed in nearly any environment and takes approximately 10 minutes to conduct.

Materials

1) Testing surfaces
   -two testing surfaces are need to complete the BESS test: floor/ground and foam pad.

   1a) Floor/Ground: Any level surface is appropriate.

   1b) Foam Pad (Power Systems Airex Balance Pad 81000)
   Address = PO Box 31709 Knoxville, TN 37930 tel = 1-800-321-6975
   Web Address = www.power-systems.com

   Dimensions: Length: 10"
   Width: 10"
   Height: 2.5"

   The purpose of the foam pad is to create an unstable surface and a more challenging balance task, which varies by body weight. It has been hypothesized that as body weight increases the foam will deform to a greater degree around the foot. The heavier the person the more the foam will deform. As the foam deforms around the foot, there is an increase in support on the lateral surfaces of the foot. The increased contact area between the foot and foam has also been theorized to increase the tactile sense of the foot, also helping to increase postural stability. The increase in tactile sense will cause additional sensory information to be sent to the CNS. As the brain processes this information it can make better decisions when responding to the unstable foam surface.

2) Stop watch
   -necessary for timing the subjects during the 6, twenty second trials

3) An assistant to act as a spotter
   -the spotter is necessary to assist the subject should they become unstable and begin to fall. The spotter's attention is especially important during the foam surface.

4) BESS Testing Protocol
   -these instructions should be read to the subject during administration of the BESS

5) BESS Score Card

(the Testing Protocol and a sample Score Card are located at the end of this document)

BESS Test Administration

1) Before administering the BESS, the following materials should be present:
   - -foam pad
   - -stop watch
   - -spotter
   - -BESS Testing Protocol
   - -BESS Score Card
2) Before testing, instruct the individual to remove shoes and any ankle taping if necessary. Socks may be worn if desired.
3) Read the instructions to the subject as they are written in the BESS Testing Protocol.
4) Record errors on the BESS Score Card as they are described below.

Scoring the BESS

Each of the twenty-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the subject. The examiner will begin counting errors only after the individual has assumed the proper testing position.

Errors: An error is credited to the subject when any of the following occur:

- ♦ moving the hands off of the iliac crests
- ♦ opening the eyes
- ♦ step stumble or fall
- ♦ abduction or flexion of the hip beyond 30°
- ♦ lifting the forefoot or heel off of the testing surface
- ♦ remaining out of the proper testing position for greater than 5 seconds

-The maximum total number of errors for any single condition is 10.

Normal Scores for Each Possible Testing Surface

	Firm Surface	Foam Surface	
Double Leg Stance	.009 ± .12	.33 ± .90	
Single Leg Stance	2.45 ± 2.33	5.06 ± 2.80	
Tandem Stance	.91 ± 1.36	3.26 ± 2.62	
Surface Total	3.37 ± 3.10	8.65 ± 5.13	
BESS Total Score			12.03 ± 7.34

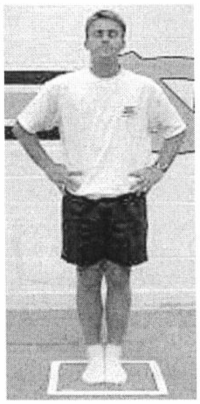
Maximum Number of Errors Possible for Each Testing Surface

	Firm Surface	Foam Surface
Double Leg Stance	10	10
Single Leg Stance	10	10
Tandem Stance	10	10
Surface Total	30	30

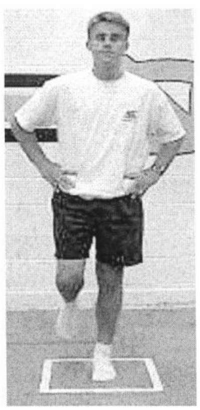
-if a subject commits multiple errors simultaneously, only one error is recorded. For example, if an individual steps or stumbles, opens their eyes, and removes their hands from their hips simultaneously, then they are credited with only **one error**.

-subjects that are unable to maintain the testing procedure for a minimum of **five seconds** are assigned the highest possible score, ten, for that testing condition.

FIRM / GROUND TESTING POSITIONS

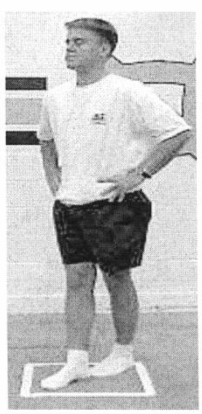


Double leg stance: Standing on a firm surface with feet side by side (touching), hands on the hips and eyes closed



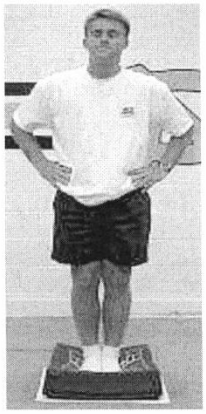
Single leg stance: Standing on a firm surface on the non-dominant foot (defined below), the hip is flexed to approximately 30° and knee flexed to approximately 45°. Hands are on the hips and eyes closed.

> *Non-Dominant Leg*: The non-dominant leg is defined as the opposite leg of the preferred kicking leg

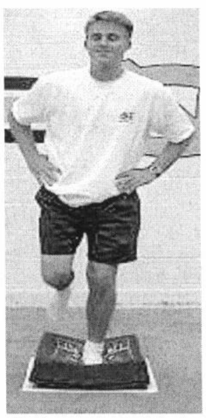


Tandem Stance: Standing heel to toe on a firm surface with the non-dominate foot (defined above) in the back. Heel of the dominant foot should be touching the toe of the non-dominant foot. Hands are on the hips and their eyes are closed.

FOAM TESTING POSITIONS

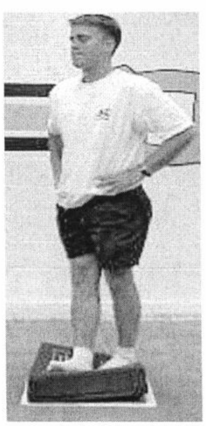


Double leg stance: Standing on a foam surface with feet side by side (touching), with hands on the hips and eyes closed



Single leg stance: Standing on a foam surface on the non-dominant foot (defined below), with hip flexed to approximately 30° and knee flexed to approximately 45°. Hands are on the hips and eyes closed.

Non-Dominant Leg: The non-dominant leg is defined as the leg opposite of the preferred kicking leg



Tandem Stance: Standing heel to toe on a foam surface with the non-dominant foot (defined above) in the back. Heel of the dominant foot should be touching the toe of the non-dominant foot. Hands are on the hips and their eyes are closed.

WARNING: Trained personnel should always be present when administering the BESS protocol. Improper use of the foam could result in injury to the test subject.

Script for the BESS Testing Protocol

Direction to the subject: *I am now going to test your balance.*

Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable).

This test will consist of 6 - twenty second tests with three different stances on two different surfaces. I will describe the stances as we go along.

DOUBLE LEG STANCE:

Direction to the subject: *The first stance is standing with your feet together like this* [administrator demonstrates two-legged stance]

You will be standing with your hands on your hips with your eyes closed. You should try to maintain stability in that position for entire 20 seconds. I will be counting the number of times you move out of this position. For example: if you take your hands off your hips, open your eyes, take a step, lift your toes or your heels. If you do move out of the testing stance, simply open your eyes, regain your balance, get back into the testing position as quickly as possible, and close your eyes again.

There will be a person positioned by you to help you get into the testing stance and to help if you lose your balance.

Direction to the spotter: *You are to assist the subject if they fall during the test and to help them get back into the position.*

Direction to the subject: *Put your feet together, put your hands on your hips and when you close your eyes the testing time will begin*

[Start timer when subject closes their eyes]

SINGLE LEG STANCE:

Direction to subject: *If you were to kick a ball, which foot would you use?* [This will be the **dominant** foot]

*Now stand on your **non-dominant** foot.*

[Before continuing the test assess the position of the dominant leg as such: the dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion]

Again, you should try to maintain stability for 20 seconds with your eyes closed. I will be counting the number of times you move out of this position.

Place your hands on your hips. When you close your eyes the testing time will begin.

[Start timer when subject closes their eyes]

Direction to the spotter: *You are to assist the subject if they fall during the test and to help them get back into the position.*

TANDEM STANCE:

Directions to the subject: *Now stand heel-to-toe with your* **non-dominant** *foot in back. Your weight should be evenly distributed across both feet.*

Again, you should try to maintain stability for 20 seconds with your eyes closed. I will be counting the number of times you move out of this position.

Place your hands on your hips. When you close your eyes the testing time will begin.

[Start timer when subject closes their eyes]

Direction to the spotter: *You are to assist the subject if they fall during the test and to help them get back into the position.*

***** Repeat each set of instructions for the foam pad**

Score Card

Balance Error Scoring System (BESS)
(Guskiewicz)

Balance Error Scoring System – Types of Errors
1. Hands lifted off iliac crest 2. Opening eyes 3. Step, stumble, or fall 4. Moving hip into > 30 degrees abduction 5. Lifting forefoot or heel 6. Remaining out of test position >5 sec
The BESS is calculated by adding one error point for each error during the 6 20-second tests.

SCORE CARD: **(# errors)**	FIRM Surface	FOAM Surface
Double Leg Stance (feet together)		
Single Leg Stance (non-dominant foot)		
Tandem Stance (non-dom foot in back)		
Total Scores:		
BESS TOTAL:		

Which **foot** was tested: ☐ Left ☐ Right
(i.e. which is the **non-dominant** foot)

APPENDIX E

Force Plate

APPENDIX E

Force Plate

Force plates are measuring instruments that measure the ground reaction forces generated by a body standing on or moving across them, to quantify balance, gait and other parameters of biomechanics.

APPENDIX F

Squat Task Analysis

APPENDIX F

A FITNESS ASSESSMENT SYSTEM
Muscular Strength
(Squat)

Name ____________________________

Date ______________________________

Test ______________________________

Abbreviate Curriculum Steps

1.1 Stand in front of the rack
1.2 Grab the bar (pronated grip) with both hands about shoulder width
1.3 Spread feet slightly wider than shoulder width
2.0 Bend knees and tuck the head under the bar and move feet to a position under the bar
2.1 Move body into a position with feet wider than shoulder width and bar resting on the upper part of the back.
2.2 Straighten the legs and lift the bar from the rack
3.1 Step back with one foot and then with the other to a position about two feet from the rack (feet slightly turned out)
4.0 Assume staring position with head up looking straight ahead and in a ready position to lift
4.1 With the chest spread and flat back position lower the body by flexing knees and hips (keep torso at the same angle to the floor throughout the lift) until the thighs are parallel to the floor.
4.2 Extent the hips and knees at the same rate and with knees out until reaching the starting position.
5.0 Step forward with one foot and then the other and put the bar back in the rack.
6.0 Tuck the head and step back out from under the bar.

Steps	UO (0)	HI PHY+ (1)	MIN PHY+ (2)	HI V/M (3)	MIN V (4)	IND (5)	TOTAL INDEPENDENCE
1.1							
1.2							
1.3							
2.0							
2.1							
2.2							
3.1							
4.0							
4.1							
4.2							
5.0							
6.0							
Sub-Totals							

______ % Task Score (# Steps Ind./12) X 100

______ Ave. Ind. Score (Sum Points/60) X 100

______ Weight Used

______ Reps/Performance Score

Observations: ____

____

Reinforcer: ____

____

Reinforcement Schedule: ____

____

Scoring Key
Unobserved (UO) – Will not attempt (0 points)
High Physical+ - Constant physical prompt, in addition to verbal prompting w/ modeling (1 point)
Minimal Physical+ - Physical to initiate, in addition to verbal w/modeling (2 points)
High Verbal/Modeling – Verbal and modeling (3 points)
Minimal Verbal – Verbal directions throughout steps (4 points)
Independence – Verbal direction to initiate (5 points)
Total Independence – Self initiation of skill, not to be considered in scoring

References

Earle, R. W., & Baechle, T. R. (2008). Resistance training and spotting techniques. In T. R. Baechle & R. W. Earle (Ed.) *Essentials of strength and conditioning* [pp 326-376]. Human Kinetics: Champaign, IL.

Jansma, P., Decker, J., Ersing, W., McCubbin, J., & Combs, S. (1988). A fitness assessment system for individuals with severe mental retardation. *Adapted Physical Activity Quarterly, 5,* 223-232.

APPENDIX G

Ariel Computerized Exercise System

APPENDIX G

Ariel Computerized Exercise System-ACES

The Ariel Computerized Exercise System – ACES, represents state-of-the-art technology which has introduced a quantum change in the application of "artificial intelligence" to the practice of resistance exercise or training and rehabilitation. As the ultimate human performance enhancing tool, ACES is well suited for sports medicine, medical diagnostics, physical therapy, rehabilitation, fitness training and biomechanical research. Developed by Dr. Gideon Ariel, a renowned authority in biomechanics, ACES automatically monitors, controls and modifies resistance and velocity, in "real-time" as the exercise is performed. The system is constantly self-adjusting to each individual's capabilities and limitations, and may be used in isotonic, isometric, and isokinetic modes or in combination. The ACES machine is capable of recording accurate measurements of movement, strength, endurance and has the capacity for storing this data for subsequent comparison of the individual's performance.

APPENDIX H

Airex Balance Pad

APPENDIX H

Airex Balance Pad

APPENDIX I

Weight Lifting Record Chart

APPENDIX I

Weight Lifting Record Chart

Name:

Age:

Height:

Weight:

DATE						

		Weight/ Reps	weight/ Reps	weight/ Reps	weight/ Reps	weight/ Reps	weight/ Reps
SQUAT	SET 1						
	SET 2						
	SET 3						
BENCH	SET 1						
	SET 2						
	SET 3						
DEADLIFT	SET 1						

	SET 2						
	SET 3						

Record Auxiliary Lifts Here: