Physical Capacity and Functional Abilities Improve in Young Adults with Intellectual Disabilities after Functional Training

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Abstract

Barwick, RB, Tillman, MD, Stopka, CB, Dipnarine, K, Delisle, A, and Sayedul Huq, M. Physical capacity and functional abilities improve in young adults with intellectual disabilities after functional training. *J Strength Cond Res* 26(6): 1638–1643, 2012—Individuals with an intellectual disability (ID) have higher rates of obesity, lower rates of physical activity, cardiorespiratory fitness, and muscular endurance than do typically developed individuals (TDI) and are twice as likely to develop chronic disease, living half as long as TDIs do. The purpose of this study was to examine the improvements in physical capacity and functional ability in Special Olympic Athletes (SOAs) aged 19–22 years after participating in a functional training (FT) program and compare these scores with those of the SOAs in a resistance weight training (WT) program. Twenty SOAs (13 men, 7 women with mild to moderate ID) participated in a 1-hour FT program, twice a week, for 10 weeks, compared with 22 same-aged SOAs (14 men, 8 women) participating in a 1-hour WT program (2× week for 8 weeks). Prefitness and postfitness tests consisting of heart rate (HR) for the 3-minute step test, static plank, body weight squats, static bar hang, and knee push-ups were conducted. Two-tailed, paired sample *t*-tests ($p < 0.05$) were used to evaluate the differences in the FT group. Change scores were used to compare FTG with the WT group. The HR decreased by 31.8 b·min^{-1} pre-post in the FTG ($p < 0.001$). Static plank duration improved by 22.4 seconds in the FTG ($p = 0.016$); static plank change scores improved ($p = 0.037$) for the FTG (26.5 ± 32.1 seconds compared with that for the WT group (4.6 ± 22 seconds). Height and weight values were unchanged in both the groups. The results of this study demonstrate the value of FT programs for this population, because weight equipment is not always available in many settings.

Key Words special Olympic athletes, physical fitness, youth with disabilities, physical training, programs, exercise therapy

Introduction

Type 2 diabetes, hypertension, heart disease, peripheral arterial disease, stroke, osteoporosis, and cancer are just some of the severe conditions being facilitated by the ever-increasing sedentary lifestyle that is prevalent in today's population (2,3,7,15,16,36). One remedy for this problem is to become more physically active. Multiple studies have shown the benefits of both functional and resistance training in the general population, but there is a dearth of research in populations with disabilities. Functional training (FT) can be described as a progressive and individualized resistance program using weight-bearing, multiplanar exercises, designed to improve performance of activities of daily living (ADLs) and recreational and sports performance (4). As Kraemer aptly states "the appropriate use of basic principles involving proper progression, variation, and individualization of resistance training (repetitions vs. strength) are the crucial factors in training success" (3).

Improvements have been observed in muscular strength and endurance, aerobic and physical work capacity, body composition, metabolic function, performance of ADL, recreational pursuits, and sports performance (4,7,8,20,21,28,34–36,38). However, there is a paucity of studies showing these benefits for young adults and college-aged students with intellectual disabilities (IDs) (6,10,14,22,33,36). Because individuals with ID often experience premature aging (leading to increased deconditioning and morbidity) and thus a greater risk of poor balance and manual dexterity (which can lead to a higher risk of falling, difficulty performing vocational and social tasks, and ADLs), it follows that this population possesses an even greater need for quality fitness programs. Moreover, an increase in neuromuscular system function, coordination, proprioception, dynamic and static balance, and core muscle strength from a variety of resistance and functional exercises can

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improve physical capacity and ability to perform the aforementioned tasks and activities (4,24,36,41).

Furthermore, Rimmer and Kelly showed that a high-intensity resistance training program can induce dramatic increases in muscular strength and endurance in this population in 9 weeks (22), and more recently, Tamse et al. demonstrated these improvements in only 6 weeks (36). With regard to FT, Whitehurst et al. showed significant results in balance and directional challenges, weight transfer activities, and negotiable obstacles in a program that took place within a 12-week program (4,41). Other studies have begun to demonstrate that even programs of a lower frequency and intensity can be beneficial for improving fitness and coordination (25,33,36).

Additionally, many competitions such as Lift America and Special Olympics provide opportunities for adolescents with ID to engage in physical activity and lower their risk of developing health problems. With the increasing number of Special Olympics Athletes (SOAs) worldwide (currently 3.7 million), there is a greater need for more research regarding the benefits of resistance and FT programs on the physical capacity and functional ability of this unique population (4,26,27,36). Physical fitness facilities are readily available for the mainstream population, but the accessibility to these facilities to SOAs is still a concern. With accessibility to these facilities, along with trained supervisors and volunteers, this population could engage in, and reap, the benefits of increased physical activity such as improving cardiofunctional capacity, muscular strength and endurance, flexibility, balance, neuromuscular improvement, and an overall improvement in physical well-being, social skills, and self-efficacy (10–12,19,23,25, 31,32,36,37). However, when such facilities are not available, could simple, FT exercises, be beneficial?

Therefore, the purpose of this study was to examine whether there are improvements in physical capacity and functional ability in young, SOA adults after participating in a FT program. We hypothesized that (a) there would be an improvement in cardiovascular capacity and muscular strength and endurance after FT was administered and (b) that they would show similar improvements with that of the comparable SOA groups that previously participated in a resistance training programs. The intention was to see if FT could substitute for resistance weight machines, because these are not always available in many settings.

Methods

Experimental Approach to the Problem

Twenty SOAs participated in a FT program, twice a week for 10 weeks, compared with 22 same aged SOAs participating in a WT program twice a week for 8 weeks. The independent variables consisted of the pretraining and posttraining tests of HR, 3 min step test, static plank, body weight squats, static bar hang, and knee pushups. The two-tailed, paired sample t-tests were used to evaluate the differences in the FT group. Change scores were used to compare the FT Group with the WT group. A two-tailed, paired sample t-test design, using SPSS (version 19.0) was employed for this study.

Subjects

A subject group of 20 SOA adults, aged 17–22 years (13 men, 7 women) were recruited from a school in North Central Florida to participate in a supervised moderate intensity FT program (1). Table 1 provides further demographic information. Each subject was informed of the experimental risks, before participation. The SOAs volunteered for the study with consent from their teachers, parents or legal guardians, and with the physician's approval, which included the completion of Special Olympics Medical Release Forms. Further, the parents or legal guardians completed the university's Institutional Review Board (IRB) approved Informed Consent Form (ICF), and each student, under the direct supervision of parent or legal guardian completed the ICF Assent Script approved by the IRB at the University of Florida (UF). The SOAs were recruited from the Sidney Lanier Center school (SLC), in Gainesville, FL, and were involved in the study as part of their physical education class. These students had varying degrees of mild to moderate IDs (and had competitive experience in basketball, bowling, and track and field events). Some of these individuals had secondary conditions such as mild cerebral palsy, or autism spectrum disorder, but were able to communicate, were ambulatory, and were capable of performing all the exercises tested with supervision. The subjects had not participated in any physical training for at least 5 months before the start of the study. All the participation days (testing and training) were very structured; the subjects came to the campus to participate after their prearranged, controlled school lunch (which was eaten after their morning of largely sedentary vocational activities). The Principal Investigator, SLC instructors, College of Health and Human Performance interns, and student volunteers supervised the participation.

Table 1. Participant demographic data.*

Groups	Men	Women	Age	Height (m)	Mass (kg)	BMI (kg/m^2)
Functional training	13	7	19.2	1.64	79.1	29.0
Weight training	14	8	19.5	1.62	74.5	28.4

*BMI = body mass index.

Procedures

Each subject was then tested before the training program by using a series of assessment exercises that were collected from the Brockport Physical Fitness Test (BPFT). This was done to establish a baseline benchmark (pretest) upon which to compare the posttest after the training program was complete. The BPFT has been approved for the subjects within the age range of 10–17 years, with and without disabilities (9,39,40). These assessment tests were used and considered to be appropriate because they fell within the high school age range, and our students though of a slightly higher age range are mentally considered high school students. The assessment tests that were used to determine aerobic functioning, body composition, and musculoskeletal fitness were the 3-minute step test, height, weight, body mass index, push-ups (modified), body weight squats, static bar hang, and static plank (40). Previous research physical fitness test data collected from individuals with ID have a high test-retest reliability ($r = 0.80$) (13).

The SOAs were then administered the FT program. The program consisted of a 60-minute workout 2 times per week for a period of 12 weeks. The first 30 minutes of the workout consisted of FT exercises (Figure 1). Progressions involved using light-enough weights so that proper form could be accomplished and increasing the repetitions, resistance, or time and performing the exercises as long as proper technique was maintained. With exercises using free weights, a target minimum of 8 repetitions and a maximum of 12 repetitions was sought; when this range was exceeded, the resistance was increased so that the 8–12 range could be reattained. Motivation to accomplish this was provided by 3–4 UF volunteers (with one bearing a clipboard) participating alongside the subjects performing the same tasks and cheering them on, with informed feedback as to how much better their exercise was (in resistance, reps, form, and time), or needed to be, to exceed what was done in the previous session. Pedagogically, the inclusive participatory format was found to be very advantageous; however, if the participant was having a particularly "bad" day, a quiet declaration of how a classmate rival (often of the opposite sex) was doing would result in a personal best performance. The next 20 minutes of the exercise program was devoted to participation in an aerobic activity, which comprised sport activities, specifically adapted to require constant movement by all the participants (e.g., noodle soccer, multipitcher and base kickball, dance marathons, stadium steps and ramps workouts, basketball, Special Olympics training [practicing for their upcoming events such as dashes, throws, and broad jumps], obstacle courses with callisthenic station and relays). The last 10 minutes of the FT program was reserved for a group proprioceptive neuromuscular facilitation stretching session using the hold-relax technique (of stretch, contract, relax, and stretch again) (29,31).

Warm-up exercises:
Jog in Place
Squat Jacks
Butt-Kicks
Shuttle Run

Main Work Out
Day 1: Arms & Abs
Bicep Curls
Static Curls
21 Curls
Hammer Curls
Dips
Overhead Triceps Extensions
Oblique Twists
Static Plank
Flutter Kicks
Cats & Cows

Day 2 AND Day 4: Plyometrics
Suicides
Squat Jumps
Jump Twists
Lateral Squats
Mountain Climbers
High Knees
Carioca's
Side Shuffle
Oblique Twists
Static Plank
Flutter Kicks
Cats & Cows

Day 3: Chest & Back
Knee Push-Ups
Wide Knee Push-Ups
Close Knee Push-Ups
Butterflies
High Pulls
Standing Dumbbell Rows
Lateral Raises
Romanian Dead Lift
Shoulder Shrugs
Oblique Twists
Static Plank
Flutter Kicks
Cats & Cows

Figure 1. Functional training exercises performed.

Statistical Analyses

The independent variables consisted of the aforementioned preprogram assessments. These values were analyzed using a 2-tailed, paired sample t-test in SPSS (Version 19.0). The

Table 2. Functional assessments before and after training.*

Assessments	Pretest	Posttest
3-min Step test (HR ± *SD*)*	145.3 ± 7.6	113.5 ± 7.9
Static plank (s ± *SD*)†	26.6 ± 45.0	49.0 ± 69.8
Body weight squats (reps ± SD)	20.3 ± 7.5	21.3 ± 9.1
Static bar hang (s ± *SD*)	11.7 ± 14.2	13.0 ± 16.8
Knee push-ups (reps ± *SD*)	21.4 ± 11.7	21.7 ± 11.8

*HR = heart rate.
†Significant difference between pretest and posttest ($p < 0.05$).

results were then compared with the past SOAs' performances in resistance training programs using difference scores subjected to 2-tailed, paired sample *t*-tests. Specifically, the 3-minute step test and the static plank were evaluated because these tests were conducted in both comparison groups. The descriptive data are presented as mean ± *SD* ($p < 0.05$). The populations of the previous training programs were of the same demographic status as that of the SOAs of this FT program. The SOAs participated in 3 sets of pretesting and posttesting. The first session focused on a resistance training program that consisted of 2 workouts per week over a period of 12 weeks. After this, the SOAs participated in another exercise program that consisted of resistance training primarily and added in some minor functional exercises. After these training sessions, the SOAs were administered an FT program that included major functional movements and minor resistive movements by adding weight to the functional movements. Each exercise program consisted of the same frequency and period length. Pretests and posttests were conducted at the beginning and end of each of these training sessions.

Results

In regards to the first hypothesis, all FT assessments showed improvement from pretesting to posttesting although significance was reached in only 2 of the 5 assessments (Table 2). Heart rate taken after the 3-minute step test was significantly reduced ($p < 0.001$) by 31.8 b·min^{-1}. Static plank duration improved after training by 22.4 seconds in the FT group (FTG) ($p = 0.016$). Repetitions of body weight squats and push-ups and time performing static bar hang did not change as a result of training ($p > 0.05$).

With respect to the second hypothesis, the functional tests that were analyzed in both the resistance (weight training) and FTGs were the static plank and the 3-minute step test. Static plank change scores improved significantly ($p = 0.037$) for the FTG (26.5 ± 32.1 seconds), compared with those of the weight training group (4.6 ± 22.0 seconds). Heart rate change scores did not vary between groups ($p > 0.05$). Height and weight were unchanged in both groups, as expected because of the age of the participants.

Discussion

The first hypothesis, regarding the efficacy of FT, was confirmed. The second hypothesis as well, comparing fitness improvements in resistance training and FTGs, indicating that FT may be as efficacious as resistance training, was likewise supported. Physical activities including resistance training via weight machines, or FT exercises, are beneficial for everyone and arguably essential for individuals with ID because of their associated health risks (36). Improved muscular strength and physical fitness have been found to be positively correlated to increased productivity in this population while performing vocational tasks (3,16–18). Additionally, because physical activity decreases throughout the lifespan of people with and without ID, educating youth about the benefits of a regular exercise program may promote consistency of exercise, even into middle and old age (31,36). Because of the implementation of this program over 2 decades ago, the participants with ID have excelled in Special Olympics competitions and more importantly demonstrated increased efficiency in their vocational tasks such as stocking shelves, bagging groceries, carrying boxes, standing for long periods of time folding laundry, and various other duties in the workplace (as measured by the total absence of supervisor complaints in this regard) (36). With these tasks as functional goals to pursue, it seems logical that FT exercises (because the movements are closely aligned with these needs) would have a very relevant role to play, especially considering the principle of sport (task) specific training. Also, most weight training on machines is done as an open-chain movements, whereas most FT involves more closed chain movement (e.g., body in contact with the floor), similar to the needed vocational tasks and many of their ADLs.

It has been established in previous studies that physical fitness test data collected from individuals with IDs have a high test-retest reliability ($r = 0.80$) (13,36), and as such, their results can be trusted, repeated, and respected. Also, not surprisingly because of established principles of specificity of training, the static plank scores showed significant improvement in the FTG because this exercise, and similar ones, were performed during the training sessions. Conversely, because exercises similar to these were not performed in the resistance weight training group, it is logical that this group showed no improvement in this test. Likewise, because both groups participated in a 20-minute bout of aerobic sport activities, and both the FTG and the weight training group featured relatively high repetitions of exercises, it follows that the step tests would improve significantly, from pretesting to posttesting in both groups and not between the groups, because both improved similarly. This has strong implications for conducting exercise programs for individuals with intellectual disabilities, even in the absence of access to weight machines; in fact, FT appears to be similarly valuable in improving the physical capacity and functional ability. Moreover, using the Step Test, a functional movement they are used to doing (steps), provides a smaller learning curve (vs. a treadmill that is more foreign); thus, there was minimal learning of a new technique to be mastered. So, when a significant heart rate difference is seen in the prestep to poststep tests, seemingly, the only thing that can be causing this is an improved work capacity, rather than a learning component (as is argued with some treadmill studies). So not having a treadmill, but only a step test, may actually support test validity for the study. Thus, a lot of expensive testing and weight equipment is not necessarily needed; the simpler and direct way actually may be preferable.

Finally, the results appear to uphold the beliefs that FT targets the "neuromuscular groups and the nervous system." (4) Thus, more than isolated muscles and muscle groups are being trained, in fact, the integration of the motor units needed to improve actual motor skills such as dynamic and static balance, coordination, proprioception (which involves the muscles responsible for the needed joint movements and the motor units needed for the stabilization of the spine, hip, and scapulae needed for functional movements).

An increase in neuromuscular system function, coordination, proprioception, dynamic and static balance, and core muscle strength from a variety of resistance and functional exercises can improve the physical capacity and ability to perform the aforementioned tasks and activities (4,24,36,41). It is clear that further research is indicated to study the physical (and social and emotional) effects of traditional and FT programs and their possible interactions.

Practical Applications

Certainly, this exercise program provided significant benefits to the participants in both the weight training and functional training groups. But in addition to these physical benefits, the social benefits of such programs are becoming more appreciated (34,36). Therefore, by participating in this training program, both these exercise groups also gained invaluable social interaction with their peers, and the university volunteers assisting with program, who in turn, benefitted socially (36). Moreover, the promise that FT can be an effective alternative to the traditional, more expensive, resistance training exercising with weight machines, cannot be overstated. The FT requires little or no equipment and is one piece of a healthy, holistic, approach to training, which can benefit individuals of all ages (4) and abilities. It is thus an inexpensive, portable, and accessible method to help people with disabilities become, and stay, more physically active.

Therefore, with sufficient planning, successful exercise and fitness programs are possible to achieve, whether relying on traditional weight training equipment, or choosing to focus on FT alone or selecting some combination of the 2. Thus, the benefits of exercise seem to be attainable with either, or both, types of training. Clearly, future research is indicated to examine the best types of functional exercises for the most physical benefits. Likewise, the social and emotional benefits for such programs should also be investigated. In conclusion, there is a critical need to improve society awareness and appreciation of such programs, community participation is valuable, and the programs must be accessible. It is essential that more people become involved in exercise programs. The availability of expensive weight machines may not be as necessary as once thought; indeed, practical based, FT programs may offer similarly significant benefits for all, with and without, disabilities (31,36).

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