Relationship of Muscular Strength on Work Performance in High School Students with Mental Retardation

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Abstract: The relationship of muscular strength on work performance measures in high school students with mild mental retardation was investigated. Ten students from a self contained Special Education class were matched according to age, gender, height, and weight then randomly assigned to either the treatment group or control group. The treatment group participated in a twelve week strength training program while the control group participated in low intensity recreational activities. Isometric strength and work performance measures were collected three times throughout the training, six weeks apart, with a retention measure collected six weeks past training. Vocational measures included: box stacking (timed repetitions), pail carry (timed distance), dolly cart push (timed distance), and sack carry (speed). Peak isometric strength measures were assessed bilaterally for: elbow flexion and extension, shoulder abduction, knee flexion and extension. Based on a randomized complete block design with repeated measures, results indicated a significant difference between post to pre test on each vocational task. In addition, all isometric strength measures indicated a significant difference between groups. Retention measures indicated decreases in work performance and isometric strength for both groups. Based on data analysis, it was concluded that participation in a school and community based strength training program was effective in increasing physical functioning and work related skills.

Previous research has indicated that individuals with mental retardation who are employed in the community have a higher quality of life than those who are not employed (Kraemer, McIntyre, Lee, & Blacher, 2003). For these individuals, specific skills need to be developed early in order to have the functional skills necessary to obtain and sustain meaningful employment. In this context, the school is the primary setting to develop these preparatory skills and facilitate community integration and the transition process.

Data generated from employment opportunities since the early 1950’s and schools that provide training for employment indicate that the process is not very successful (Pierce, McDermott, & Butkus, 2003). Many of the job placements provided for individuals with mental retardation are low level or entry level positions with little opportunity of advancement (Cooney, 2002; Horvat & Croce, 1995) and require a great deal of physical skill such as pushing, pulling, lifting, carrying etc. This physical component to work performance often becomes a problematic issue for this population due to their already low level of physical strength as presented by their significantly lower scores on physical assessments (Angelopoulou, Tsimaras, Christoulas, Kokaridas, & Mandroukas, 1999; Ayvazoglu, 2004; Graham & Reid, 2000; Horvat, Croce, Pitetti, & Fernandez, 1999; Horvat, Pitetti, & Croce, 1997).

Educational reform in Special Education has focused on strengthening the ties between community and school through the transition process. The transition process is designed to prepare students for the next level in educational training whether it be post secondary or supported employment (Horvat, Eichstaedt, Kalakian, & Croce, 2003). In addition, the Individual Transition Plan (ITP), mandated through Individuals with Disability Education Act (IDEA), focuses on the development of life skills for young adults with disabilities (Smith, 1998). Although ITP’s primarily focus on vocational skill development and activities of daily living, the improvement of physical

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functioning is highly correlated with functional skill development (Horvat & Croce, 1995; Seagraves, Horvat, Franklin, & Jones, 2004).

It is essential that individuals with mental retardation develop the necessary prerequisite physical skills required to perform manual labor job tasks often required of them at job sites (Croce & Horvat, 1992; Horvat & Croce, 1995). The improvement of physical functioning is also task specific and can be improved with intervention programs that correlate with work performance (Horvat, Croce, & McGhee, 1993; Seagraves et al., 2004; Serr, Lavay, Young, & Greene, 1994; Zetts, Horvat, & Langone, 1995).

Since the improvement of muscular strength has been shown to improve work productivity, the purpose of this study was to compare an individualized resistance strength training program to a traditional physical activity class in improving physical functioning and work performance in high school students with mild mental retardation.

Method

Participants

Ten participants from a high school self-contained Special Education class, diagnosed in the Mild Intellectually Delayed (MIID) category by the Director of Special Education as defined by the Department of Education guidelines, were assigned to five matched pairs based on age, gender, height, and weight. Participants were matched by the Special Education teacher and then randomly placed into the training (strength training program) or non training group (traditional physical activity). Participants had consistent attendance records, did not exhibit behavior problems, or have multiple disabilities. Participants were not enrolled in any other physical activity classes nor receiving rehabilitation services during the time of the study. Participants did not receive any academic credit for their participation in this study.

Procedure

Muscular strength. Isometric muscular strength was assessed using the MICROFET2 hand held dynamometer (Hoggan Health Industries, Cooper IL.). This device records data in pounds and has been shown to be a valid and reliable measure of isometric strength in individuals with mental retardation (Horvat, Croce, & Roswal, 1994; Horvat, Croce, Roswal, & Seagraves, 1995). Isometric strength using the mean of three trials was used on elbow flexion and extension, shoulder abduction, knee flexion and extension based on previous work with individuals with mental retardation (Seagraves et al., 2004; Zetts et al., 1995). Data collection intervals occurred prior to training (0 weeks), mid training (6 weeks), post training (12 weeks), and retention (18 weeks). Retention measures coincided with the school’s vacation period and was a period of time when students did not participate in organized physical activity. A mid training (6 week) evaluation occurred to ensure that participants were receiving a training effect.

Work performance assessment. Work performance tasks were designed to simulate employment tasks commonly performed in community job sites. Tasks were selected from observations at actual job sites and were reviewed by two vocational rehabilitation specialists, a job coach and an employer. All tasks were identified as requirements that are specific to a variety of employment settings.

Work performance was assessed in all tasks including box stacking, weighted pail carry, weighted dolly cart push, and weighted sack carry. Data on work productivity tasks was measured using a stopwatch and a tape measure. Equipment used was weighted boxes, a weighted two wheeled hand truck (dolly), two five-gallon weighted buckets, and two weighted sacks. The box stacking involved weighted (5-6 lbs) boxes and required the participants to stack as many boxes from one table, approximately 36 inches high, to an identical table approximately three feet away in a 60 second time limit. The boxes were stacked in groups of four for safety and ease of the stacking process. Participants were instructed on proper lifting techniques for all tasks prior to commencing the data collection.

The pail carry required subjects to carry two five-gallon buckets, each weighted with 20 lbs, around an oblong course of cones 35 feet long. The stopwatch started with the participants’ first movements and stopped after 30
seconds had elapsed. The score for this task was recorded in total distance covered. Running was not permitted for safety reasons and students were able to stop to regrip if necessary without penalty.

The weighted dolly cart push required participants to maneuver a cart weighted with a 25 lb box around the same course as the pail carry. Once again each participant had 30 seconds to push the cart as far as possible along the course. Scores were recorded in total distance traveled. Students could not run but could stop at any time to regrip without penalty.

The weighted sack carry required each participant to carry two five lb sacks, one on each shoulder, up and down two flights of stairs. Time was recorded on how long it took to reach the top of the stairs (sack carry up) as well as total time to ascend and descend the stairs (sack carry total). It was also recorded if any stumbles occurred. Students were not allowed to run, each foot was required to touch each stair, students were able to stop to regrip if necessary without penalty. Spotters traveled with the participants during this task to maintain safety while on the stairs.

Data Collection

Data collection for the work performance tasks were conducted in the High School gymnasium while the muscular strength assessments were collected in the classroom. All students were assessed on the same day. Prior to commencing the study, the classroom teacher was informed as to the purpose of the study and trained on each of the assessment techniques. Muscular strength and work performance data was collected by the principal investigator assisted by the classroom teacher. All students were trained on the proper lifting techniques prior to performing any of the work performance tasks. Safety procedures and proper weight lifting techniques were reviewed with the treatment group prior to commencing the strength training program.

Strength Training Intervention

Exercises for the training intervention were selected for specific muscle groups involved in work performance tasks. Initial resistance levels were established for each participant based on pre assessment data. A three day training intervention was established based on the equipment available in the instructional setting such as universal weight equipment, free weights, exercise tubing, and gravity assisted exercises. Included in Table 1 are specific daily exercises performed during the intervention program. Training sessions were conducted twice weekly at the high school and once a week at a community recreational facility. The session held at the community facility was part of the School District’s mandate for Special Education classes to facilitate placements and involvement in community programs.

Prior to participation in the exercise program, an orientation was implemented to familiarize participants with the equipment and proper lifting techniques associated with each exercise. Safety issues were emphasized and the mandatory use of a spotter was used for safety and promoting motivation to complete the training tasks. Each session consisted of a group warm-up of stretching activities, training in a circuit formation, and group cool down. Training sessions were conducted in a circuit formation to keep participants organized and on task. The exercise program had three levels of intensity and participants did not move to the next level until the prescribed criteria had been accomplished (Fleck, 2005). Successful completion of a level entailed completing a required number of sets and repetitions. Level one involved three sets of twelve repetitions, level two included three sets of ten repetitions, and level three included four sets of eight repetitions. The exercise program

<p>| TABLE 1 |</p>
<table>
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<tr>
<th>Resistance Strength Training Program by Day</th>
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<tr>
<td><strong>Day 1 (School setting)</strong></td>
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<tr>
<td>Bench press</td>
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<td>Heel raises</td>
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<td>Push ups</td>
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was implemented three times a week for twelve weeks, each session lasted approximately 60 minutes. In contrast the non treatment group participated in game and sport activities that involved walking, ball skills, and games in the same setting. These activities imitated activities that would have occurred in a high school physical education class.

**Experimental Design**

A randomized complete block design with repeated measures was chosen to analyze strength and vocational performance. Each block consisted of matched pairs based on gender, height and weight. None of the matching attributes were dependent variables as outlined by Huck (2000). In a block design, participants are assigned to a homogeneous group of some form. Each block is a form of control and allows more precise conclusions to be drawn based on each block (Yates, Moore, & McCabe, 2001). By blocking some sources of unavoidable variability between groups can be eliminated. A blocking design reduces the variance and thus increased the statistical power of the study (Dehlert, 2000). Randomization within each block averaged out the effect of the remaining variation thus allowing an unbiased comparison of the two treatment groups (Moore & McCabe, 2002). Participants were initially blocked by the classroom teacher and randomly assigned to either the treatment or control group.

**Results**

**Group Comparison**

An one-way ANOVA was performed to determine differences between groups from pre to post test assessments periods for each vocational task. Significant differences were found between treatment and control groups at $p \leq .05$ for each of the following vocational tasks; box stacking, $F(1, 4) = 20.39, p < .005$; pail carry, $F(1, 4) = 13.16, p < .01$; dolly cart push, $F(1, 4) = 112.64, p < .002$; sack carry up, $F(1, 4) = 4.02, p < .05$, and sack carry total, $F(1, 4) = 4.12, p < .05$.

An one-way analysis of variance (ANOVA) was performed to determine differences between groups from pre to post test assessment periods for each muscular strength assessment site. Significant differences were found between the treatment group and control groups at $p \leq .05$ for muscular strength; Dominant upper body, $F(1, 4) = 20.19, p < .009$; Non dominant upper body, $F(1, 4) = 8.87, p < .039$; Dominant lower body, $F(1, 4) = 8.74, p < .02$; and Non dominant lower body $F(1, 4) = 8.73, p < .02$. In contrast, no significant differences were evident at $p > .05$ for muscular strength assessments between any of the blocks indicating that the differences occurred from the intervention rather than blocking.

**Percent Change**

Percent change was also calculated for each vocational task across each assessment period. One of the most noteworthy results was the percent change from pre to post test, which indicated the increase in work performance from 0-12 weeks (Figure 1). Box stacking for the treatment group increased 42.4% (11.2 boxes) and the control group increased 11.02% (2.8 boxes). The treatment group increased 30.12% (14.1 m) on the pail carry while the control group increased 12.52% (5.61 m). The dolly cart push for the treatment group increased 30.31% (14.14 m) while the control group increased 10.87% (4.48 m). The treatment group decreased their time in the sack carry up by 35.48% (5.73 sec) and the control group decreased 19.89% (3.53 sec). The treatment group decreased their time in the sack carry total by 21.92% (6.36 sec) while the control group decreased 12.5% (3.91 sec).

At retention, performance decreases were evident for each vocational task (Figure 2). The treatment group decreased 11.7% in box stacking while the control group decreased 5.67%. Pail carry performance decreased in the treatment group 9.69% and the control group decreased 6.5%. The dolly cart push decreased 10.12% for treatment group and 5.85% for the control group. Time in the sack carry up increased 19.77% for the treatment group and 9.00% for the control group. Time for the sack carry total increased 9.00% for the treatment group and 0.88% for the control group.

Data analysis of muscular strength indicated
a training effect present at each assessment location following the 12 week intervention strategy as displayed by percent change from pre to post assessment periods (Figure 3). Dominant upper body assessment for the treatment group demonstrated a 51.19% increase in strength while the control group increased 4.4%. The non-dominant upper body assessment increased 56.97% for the treatment group and the control group increased 13.78%. Strength measures decreased once the intervention strategy ceased and was measured six weeks post training, through the retention measure (Figure 4). The dominant

Figure 1. Percent change from pre to post assessment for each vocational task.
upper body decreased 20.85% for the treatment group and 15% for the control group. Non-dominant upper body deceased 19.76% in the treatment group and 8.31% for the control group.

Assessments on the lower body for the treatment group dominant side increased 48.11% and the control group increased 14.07% from pre to post test. Non-dominant lower body increased 55.81% for the treatment group and 9.58% for the control group. Decreases in muscular strength could be seen as early as 6 weeks post intervention strategy. Lower body dominant assessment decreased 24.05% and the control group decreased 9.23%. Non-dominant lower body decreased 28.93% for the treatment group and 6.03% for the control group.

Figure 2. Percent change from post to retention measures for vocational tasks.
Discussion

Our results indicate that significant increases in physical functioning and work performance were apparent after participation in a school and community based resistance training program. Based on previous research the increases in work performance and muscular strength were expected (Croce & Horvat, 1992; Seagraves et al., 2004; Zetts et al., 1995). In each context, when intervention programs were utilized for individuals with mental retardation, the participants increased their overall functioning as well as developed specific skills.
such as work performance measures. The intervention is correlated to the transition process and supports the effectiveness of a school and community based program. Work performance skills can be dramatically improved from resistance training intervention in a setting that is parallel to what is available to most Special Education teachers.

It should be noted that significant differences occurred between the treatment group and the control group at $p \leq .05$ for all vocational tasks (box stacking, pail carry, dolly cart push, sack carry). This finding is important since improvement in physical functioning can generalize to performance in work related tasks. In addition, the implementation of the
program in the school and community setting by Special Education teachers emphasize the importance of the school in developing parallel tasks for vocational tasks that can be used in transition programs. For transition purposes, this model may be helpful in preparing individuals with mental retardation for integration into the community both from the perspective of work performance skills as well as improving their physical health and well-being through strength training.

Performance was greater in this study than results from earlier investigations most likely due to the functional level of the participants and relative mild diagnosis involved as opposed to the participants in the moderate – severe range of mental retardation which were in earlier studies (Seagraves et al., 2004; Zetts et al., 1995). In addition, training interventions occurred three times weekly for 12 weeks in contrast to previous studies that implemented twice weekly training interventions for 10 weeks. In each case, it is apparent that a structured training protocol albeit two or three times weekly can produce benefits in physical and vocational functioning.

Performance of box stacking, pail carry, and dolly cart all represent significant increases in the treatment group. These tasks are common in work environments and demonstrate that job performance can be improved with a school and community based exercise intervention program. This is specific to accountability standards for schools and transition teams in developing and implementing successful transition program. It also supports the importance of intervention prior to job placements as a way to provide the prerequisite skills for an individual with mental retardation prior to job placements.

The sack carry was not previously tested in earlier studies but after consultation with a job coach, was recommended to simulate a specific job skill frequently required in the work environment. This task requires the ability to integrate strength, balance and requires a higher level of physical functioning to perform the task. In our study, the sack carry improved 32.7% for the treatment group as opposed to 16.2% for the control group with neither group experiencing any stumbles or falls during performance.

A critical component of this study was the effect of withdrawing training on performance. In all measures, retention measures revealed a decrease in physical and work performance. This deterioration of functioning emphasizes the importance of the intervention protocol on specific training on physical and work related tasks. A decrease in functioning was apparent in previous work demonstrating as training diminishes gains in functioning also decrease (Croce & Horvat, 1992; Seagraves et al., 2004; Zetts et al., 1995). The continuation of training throughout the academic year should be encouraged because this population is not active enough outside of school to maintain these gains by their own volition. Further, instruction in a community setting for training sessions is a feasible strategy that can be implemented to initiate students and encourage them to continue this practice outside of school hours or over summer to help maintain functional ability.

It is also important for members of the transition team to carefully plan and coordinate the experiences necessary in the transition process. The ITP needs to address the feasibility of providing support in the training interventions on a continual basis. Since the loss of employment is high in this population job retention may be associated with maintaining a level of physical functioning that is necessary to complete physical tasks commonly seen in employment settings. Therefore it is essential that the development of physical skills required to successfully perform specific work related tasks by addressed through the planning and implementation of programs through their school curriculum.

References


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Received: 13 July 2005
Initial Acceptance: 10 September 2005
Final Acceptance: 16 February 2006