EFFECTS OF A COMMUNITY-BASED FAMILIARIZATION INTERVENTION ON INDEPENDENT PERFORMANCE OF RESISTANCE-TRAINING EXERCISE TASKS BY ADULTS WITH INTELLECTUAL DISABILITIES

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Effects of a Community-Based Familiarization Intervention on Independent Performance of Resistance-Training Exercise Tasks by Adults with Intellectual Disabilities

Abstract

Adults with intellectual disabilities (ID) have significantly lower levels of fitness compared to general population. The study examined the effects of a multi-component familiarization intervention, consisting of a visual activity schedule and a video-enhanced system of least-to-most prompting both displayed via an iPad, on the acquisition of resistance-training exercise tasks by adults with ID, aged 18-44 years, in a community fitness center. Twelve participants were randomly allocated to an experimental group (EG) and 12 to an active control group (CG). ANOVA revealed EG correctly and independently performed a significantly greater number of steps of four resistance-training exercise tasks compared with CG, relative to preintervention levels (p<.01). The intervention was effective in promoting functional performance of resistance-training exercise tasks among adults with ID.

Keywords

Exercise performance; intellectual disability; prompting; video-based instruction; resistance training

Insufficient levels of physical activity among adults with ID have been an established health concern for over a decade. A recent systematic review (Dairo, Collett, Dawes, & Oskrochi, 2016) indicates that only nine percent of adults with ID meet the Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services, 2008). Further, adults with ID have significantly lower levels of physical fitness (Graham & Reid, 2000) and less frequently participate in fitness activities (Barnes, Howie, McDermott, & Mann, 2013) compared to the general population. Those findings are troubling considering that physical fitness influences health- and work-related outcomes in adults with ID (Bouzas, Ayán, & Martínez-Lemos, 2018; Cowley et al., 2011; Croce & Horvat, 1992; Shields, Taylor, & Dodd, 2008). Exercise is important in promoting physical fitness among adults with ID. While fitness centers could be ideal places for people with disabilities to engage in exercise and meet the recommended levels of physical activity (Rimmer, Padalabalanarayanan, Malone, & Mehta, 2017), a recent review (Calder, Sole, & Mulligan, 2018) showed that physical and system access barriers limit their ability to do so. Furthermore, many fitness professionals do not have the necessary professional education and resources to meet the needs of a diverse range of populations (De Lyon, Neville, & Armour, 2017), including adults with ID (Calder et al., 2018; Howie et al., 2012; Rimmer et al., 2017).

In 2001, the World Health Organization (WHO) published a framework that integrated previous models of functioning and disability, the *International Classification of Functioning Disability and Health* (ICF) for adults. In this framework, *functioning* is an umbrella term that refers to all body functions and structures, activities and participation, while *disability* is an overarching term for impairments, activity limitations, and participation restrictions. Impairments are defined as problems in body function or structure. Activity limitations are difficulties in carrying out daily activities (e.g., fitness exercises). Participation restrictions are problems in life or social situations (WHO, 2001). The ICF activity and participation dimensions of functioning are evaluated using two qualifiers: the performance qualifier (i.e., how accurately and independently a person completes tasks) and the capacity qualifier (i.e., how willing and able a person is to execute tasks). A person's functioning and disability, including her/his participation, are considered to arise from the interaction among health conditions, environmental factors (e.g., layout of the gym, availability of equipment, service availability), and personal factors (e.g., age, sex, other health conditions, past or current experience, values, lifestyle). Because health and function cannot be artificially separated from other aspects of life and all facets of life can affect health and function, McDougall, Wright, and Rosenbaum (2010) proposed a modified model of the ICF (see Figure 1). This model depicts a person's life quality and ultimately her/his potential for growth and development as outcomes and processes that arise from the interconnected, ever-changing influences of all components of the ICF.

The ICF makes it possible to identify and monitor the effectiveness of intervention strategies in selected domains of functioning (Üstün, Chatterji, Bickenbach, Kostanjsek, & Schneider, 2003). Although adults with ID are capable of functioning in fitness centers, they often struggle to respond to natural cues within the exercise environment. For example, an exercise log can be considered a natural cue that informs a person what exercise tasks s/he needs to complete in a particular circuit training workout. Likewise, the visual appearance of a clean machine after wiping it down can be a natural cue that informs a person to move on to the next exercise task. When a natural cue is not yet sufficient for a person to perform the appropriate behavior correctly and independently, supports in the form of adaptations, technology, or instructional prompts can increase the likelihood that the behavior will be performed

(Billingsley, 2003; Obrusnikova, Novak, & Cavalier, 2019; Thompson, Shogren, & Wehmeyer, 2016). However, if a fitness professional does not fade (i.e., decrease in intensity) a particular support strategy as a person's performance improves, that person's potential to function independently will be severely compromised (Koyama & Wang, 2011).

A research-validated prompting-and-fading strategy to teach independent performance is a *visual activity schedule* (VAS). McClannahan and Krantz (2010) defined a VAS as a visual support strategy that uses visual cues, such as line drawings, photographs, and/or written words, to prompt a person to follow a sequence of steps or tasks. Numerous studies have demonstrated that transfer of stimulus control from a supervising adult to a VAS is effective in promoting independent task initiations and transitions, task engagement, self-management, and self-scheduling in adults with ID (Burckley, Tincani, & Guld Fisher, 2015; Spriggs, Mims, van Dijk, & Knight, 2017). Another prompting-and-fading strategy is the *system of least-to-most prompting* (SLMP), which has been extensively validated on adults with a wide range of impairments and across different settings (Doyle, Wolery, Ault, & Gast, 1988). When using the SLMP, the instructor first provides the person an opportunity to respond independently to the natural cue. If the person responds incorrectly, the instructor gradually progresses through a prompt hierarchy, ordered from the assumed least intrusive prompt (e.g., a brief verbal prompt) to the most intrusive prompt (e.g., physical guidance), until the learner performs the correct response. Because it does not require an assessment to determine a controlling prompt (i.e., a prompt that ensures correct performance of the step) nor frequent review of performance data following instructional sessions to make instructional decisions, the SLMP is particularly appropriate in situations that involve multiple fitness professionals or professionals with less experience in systematic prompting (West & Billingsley, 2005).

In recent years, researchers have investigated the utility of including video prompts in prompt hierarchies when teaching various chained tasks to persons with developmental disabilities (Banda, Dogoe, & Marie Matuszny, 2011; Obrusnikova, Cavalier, Novak, & Blair, 2019; Obrusnikova, Novak, et al., 2019; Park, Bouck, & Duenas, 2019). The benefits of video prompts include consistent visual demonstration of each step, consistent teaching methods across sessions, a consistent teacher (i.e., the model) on each trial, and no need for multiple sets of equipment to model an exercise step (Smith et al., 2015). Because video prompting delivers instructional cues via a fluid auditory and visual mode, it also can increase participants' engagement and motivation to perform the task (Mechling, Gast, & Fields, 2008). As an example, Obrusnikova, Cavalier et al. (2019) and Obrusnikova, Novak et al. (2019) used a video-enhanced SLMP to teach resistance-training exercise tasks to three young adults with mild ID and three adults with moderate ID, respectively. Results from these two single-subject design studies provided strong support for the use of a video-enhanced SLMP to promote acquisition and maintenance of different exercise tasks by participants in a laboratory-based setting and a small fitness center, respectively. On average, it took about six sessions for participants in the two studies to reach mastery of the exercise tasks (i.e., to perform about 90% of exercise steps correctly and independently). While those findings are encouraging and informative, the evidence base is so thin in the area of exercise task acquisition that additional studies with larger numbers of participants in natural community settings are needed to ensure those intervention strategies are sufficiently robust for persons with ID.

Therefore, the primary purpose of this study was to examine the effects of a six-session multi-component familiarization intervention, consisting of a VAS and a video-enhanced SLMP both displayed via an iPad, on the acquisition of resistance-training exercise tasks by a larger number of adults with ID in a community fitness center. The hypothesis was that adults with ID who received the six-session familiarization intervention will correctly and independently perform a significantly greater number of steps of four resistance-training exercise tasks compared with adults with ID who did not receive such intervention, relative to their preintervention performance. The secondary purpose was to explore the personal factors that might negatively influence performance outcomes. The current study extends previous research in two ways. First, it evaluated the effectiveness of a VAS along with a video-enhanced SMLP displayed via an iPad, whereas prior research evaluated the effectiveness of only a video-enhanced SLMP. Transfer of stimulus control from a supervising adult to a VAS during performance training was expected to further promote independent initiation and sequencing of fitness task steps (Spriggs et al., 2017). Second, to enhance ecological validity, the study was carried out in a community fitness center that contained typical environmental, programmatic, and attitudinal potential limitations to participants' exercise behavior.

Method

Study Design

The study used a pretest-posttest control-group randomized experimental design (Thomas, Nelson, & Silverman, 2015). Design and flow of participants through the trial is provided in Figure 1. Each participant was first assigned a code, which was concealed until after the randomization. After eligibility screening, a member of the research team not involved in recruitment, assessment, or training was responsible for group allocation. Allocation was performed using a block randomization method with randomly selected block sizes of 4, 2, 8, 2, and 6 (Efird, 2011). Each block was balanced across sex, disability agency, and Down syndrome. The Excel RAND formula was used to order participants in each block. Other investigators on the team were blinded to both the ordering of blocks and their respective sizes.

Participants

A total of 24 adults with ID participated in the study. Of the 24 participants, 12 (4 women) were allocated to the EG and 12 (4 women) to the CG. Four participants were diagnosed with Down syndrome (two in each condition), one with a co-morbid autism spectrum disorder and one with a co-morbid psychiatric condition that was controlled with medications. In the EG, 50% of the participants were White, 42% Black, and 8% Hispanic. In the CG, 50% of the participants were Black, 17% White, 25% Hispanic, and 8% Mixed.

The treatment of participants during the study was in accordance with ethical standards of the American Psychological Association. Institutional review board approval was obtained prior to commencement of the study. Participants were recruited through three disability agencies (two suburban and one urban), all providing transition services, supported employment, and day activity programs for adults with ID. The inclusion criteria for participation were: (a) no previous diagnosis of any chronic or co-morbid condition that could affect performance of the target exercise tasks as assessed by the *AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire* (ACSM, 2017); (b) an IQ score below 70; (c) a chronological age between 18 and 44 years; (d) a receptive vocabulary score at or above five years of age; (e) no record of currently being pregnant or undergoing hormonal replacement or cancer therapy; and (f) no prior or current experience with a similar intervention. The upper age limit was consistent with the ACSM's Risk Factor Threshold suggesting that men and women older than 44 and 54 years, respectively, are at an increased risk for a cardiovascular event during vigorous physical activity (ACSM, 2017). Adults with ID were selected because this population typically is more dependent on community-based opportunities for physical activity (Howie et al., 2012). As outlined in Figure 1, the agencies mailed a flyer promoting the study, a screening questionnaire, and consent forms to all parents or legal guardians of adults with ID (n = 34) who the program director believed met the inclusion criteria. Of that group, 28 returned consent forms. Four participants were excluded during the initial screening or preintervention testing.

Exercise Setting

The study took place in the fitness center portion of a large YMCA gym (50 x 50 meters). The center contained a large cardio zone with 20 treadmills, five bikes, and five elliptical machines; a strength circuit-training zone; and a free weights zone. There were multiple spray stations at each corner of the fitness center and music playing in the background. TV screens were positioned only on cardio machines. To assess accessibility of the fitness center, a professional version of the *Accessibility Instruments Measuring Fitness and Recreation Environments: Fitness Centre and Swimming Pool Accessibility* (AIMFREE) tool was used. Details about the instrument's development, reliability, and validity were published in Rimmer, Riley, and Rauworth (2004). A percentage score was calculated for each area in this study by adding together the number of all positive item responses (i.e., presence of an accessible feature), dividing the sum by the maximum possible number of items in the area, and multiplying the quotient by 100. Rimmer et al. (2017) reported that 70% compliance indicates acceptable accessibility. The selected YMCA scored as follows (highest to lowest): Access Routes and Entrance Areas (88%), Water Fountains (88%), Policies (87%), Programs (80%), Elevators (78%), Swimming Pool (72%), Professional Support/Training (68%), Parking (67%), Equipment (64%), Locker Rooms and Showers (63%), Bathrooms (60%), Information (55%), and Sauna (22%). Using a four-point scale in the AIMFREE, professional behavior within the YMCA was rated nearly neutral (M = 2.63, SD = 1.09). Higher ratings indicate better professional behavior.

Exercise Program

Participants in both groups completed six sessions (2 per week for 3 weeks). Four resistance-training exercise tasks (chest press, leg press, seated row, and military press) that are popular in progressive resistance training were selected. All exercise tasks were task analyzed into specific steps and sequences needed for successful performance of each exercise task in our previous work (Obrusnikova, Cavalier, et al., 2019; Obrusnikova, Novak, et al., 2019). The four exercise tasks were performed either on Life Fitness pin-loaded (chest press and seated row) or on Cybex knob-loaded (leg press) machines or on a bench with dumbbells (military press). In each exercise session, participants retrieved their personal exercise log from their instructor, which included a list of exercise tasks, repetitions/sets to be completed, and exercise machines settings (i.e., weight, seat height, and handles). After a 10-min treadmill or elliptical warm-up and stretching of major muscle groups, participants completed one set of 10 or 12 repetitions at 50-60% of 1RM for that exercise task (ACSM, 2009). Loads were estimated with the repetitions-to-fatigue method (Mayhew, Kerksick, Lentz, Ware, & Mayhew, 2004). The exercise tasks and the number of repetitions were counterbalanced across sessions to pr’vent the potential for confounding by following a rigid sequence of exercise tasks and repetitions (Mechling, Ayres, Purrazzella, & Purrazzella, 2012). Participants were oriented to the routines in one to two orientation sessions. The instructor walked to each of the four machines and explained what was expected of the participants at each station. Details about the orientation sessions can be found in Obrusnikova, Novak, et al. (2019).

Experimental Group Condition. The familiarization intervention utilized two technology-enhanced instructional strategies, a VAS and a video-enhanced SLMP, to promote correct and independent performance of the four exercise tasks. The VAS was delivered to participants via 20-cm LED iPads containing the *First Then Visual Schedule HD* app (FTVS, Good Karma Applications, Inc., China). FTVS is a tool for creating, customizing, and sharing visual supports, such as schedules, for use by people with developmental disabilities. An iPad presented the VAS to the participants via exercise icons in the FTVS app and wireless headphones. Each icon was enhanced with visual cues (i.e., a photo of the equipment and a spoken and text title of the exercise task) and could be touched to activate auditory cues for the exercise task or the step of the task to be performed. The same icons in the VAS were used by all participants. Participants were instructed on the operation of the iPads and the FTVS app during an orientation session described in Obrusnikova, Novak et al. (2019). They practiced use of the technology on two tasks not included in the analysis (treadmill walking and elliptical pedaling). Instruction continued during the intervention until a participant was able to independently operate the iPad.

The familiarization intervention (consisting of the VAS and the SLMP) was incorporated into a total-task behavioral chaining approach (Spooner & Spooner, 1984) to teach the steps of each exercise task. During this approach, each performance opportunity started with the first step and ended with the last step of an exercise task. All performance trials started with a natural cue (i.e., looking at the exercise log). If a step was performed incorrectly, out of order, or took more than 15 seconds to complete, the instructor delivered a verbal prompt to the participant. A participant would proceed to the next step if s/he responded correctly following the verbal prompt. If a participant did not respond correctly, the instructor initiated a video prompt, followed (if necessary) by a gestural prompt, and then a physical prompt. In the video prompt, the instructor asked the participant to find the exercise task in the FTVS and then click on the specific step icon, which would then play a 5- to 10-second video clip of a trained female college student performing the step of the exercise task. The video clips were enhanced with auditory and visual cues (i.e., color line drawings) to indicate directions of movement and help focus attention on a particular body part. If a participant made an error during the exercise execution (e.g., did not have high elbows when performing 10 repetitions), the instructor would stop the set of repetitions, apply the necessary prompt, and then ask the participant to continue the remaining repetitions in the set. Any new errors in the next repetitions would be corrected. A verbal prompt was applied when the participant engaged in an off-task or an inappropriate behavior (e.g., to redirect talking to others/self, hitting the seat). If this were unsuccessful, the instructor physically guided or redirected the participant back to the exercise task. Participants received non-specific, verbal praise (e.g., "good effort," "good try") after an average of every third exercise step for general attending and attempting to perform the steps. This procedure was followed for each step until all exercise steps were performed correctly in the task. Both the VAS and the video prompts were piloted and content validity, relevance, and readability of the videos were established with the same machines and population in studies by Obrusnikova, Cavalier et al. (2019) and Obrusnikova, Novak et al. (2019).

Control Group Condition. The same exercise program (i.e., the same setting, exercises, exercise log, natural cues, procedural script, and praise) as in the EG were used in the control group condition to alert a participant to begin a task, minimize inappropriate behavior, and remind the participant to stay engaged, followed by an opportunity to perform the task. If the participant made a mistake that could not be ignored (e.g., set a very heavy weight) or took more than 15 seconds to complete a step, the instructor performed the step for the participant out of her/his view. Neither the VAS nor the SLMP were provided to participants in this condition.

Baseline Measures of Body Structure and Function

Both impairment and physical performance measures were used to assess body structure and function (Reiman & Manske, 2011). Their selection was made based on their utility in previous community-based resistance training studies with the target population (Cowley et al., 2011; Shields et al., 2008). *Body Mass Index* (BMI; weight[kg]/height[m]^2) was used to measure body structure in this study. Cognitive abilities were assessed with the *Wechsler Abbreviated Scale of Intelligence-Second Edition* (WASI-II; Wechsler, 2011). WASI-II is a battery of four subtests, which combine to yield a Full-Scale Intelligence Quotient (FSIQ-4) score to determine overall cognitive abilities. The Vocabulary and Similarities subtests form a Verbal Comprehension Index (VCI) score, and the Block Design and Matrix Reasoning subtests form a Perceptual Reasoning Index (PRI) score. Receptive vocabulary skills were assessed with the *Receptive One-Word Picture Vocabulary Test-Fourth Edition* (ROWPVT-4; Martin & Brownell, 2011). Static balance was assessed with the *Unipedal Stance Test* (UPST; Bohannon, Larkin, Cook, Gear, & Singer, 1984). Two measures of functional performance were administered to participants, *the Six-Minute Walk Test* (SMWT; American Thoracic Association, 2002) and *the Stairs Climb Test* (SCT; Nightingale, Pourkazemi, & Hiller, 2014). The SMWT is a submaximal field test of functional capacity during which participants walked a 50-foot course in the gym. The distance walked in six minutes was measured to the nearest cm. The SCT is a field test of functional capacity during which participants as quickly as possible ascend, turn, and descend 10 stairs (about 25 cm deep and 16.5 cm high). Participants could choose any method of traversing the stairs but they had to take one step at a time and not use the handrails for support. Total time to ascend and descend stairs was measured to the nearest 100th of a second. Best of three trials was used for data analysis. The two functional measures were well validated for persons across the age span in prior studies (Bohannon, Bubela, Wang, Magasi, & Gershon, 2015; Nightingale et al., 2014). Baseline measures were administered by a psychometrician or the investigators using the tests' standard administration procedures.

Outcome Measures

Participant performance of the four resistance-training exercise tasks was assessed before and after the intervention using procedures described under the Control Group Condition. A Sony Handycam camcorder was used to record performance of each exercise task. To observe and code exercise performance, Obrusnikova, Cavalier et al. (2019) and Obrusnikova, Novak et al. (2019) developed a coding manual for the four exercise tasks following guidelines proposed by Yoder and Symons (2010). The manual includes names of steps for the four exercise tasks, a description of each exercise step, rules for assigning codes, and examples of codes. Based on recommendations made by Obrusnikova, Cavalier et al. (2019), the research team split a step that involved throwing away a used wipe and returning a spray bottle into two steps, resulting in 18 steps for the chest press and leg press and 19 steps for the seated row and military press. Steps for each exercise task were categorized into three phases—preparation, execution, and clean-up. A list of steps for the chest press and leg press were published in Obrusnikova, Cavalier et al. (2019). A list of steps for the seated row and military press will be provided upon request.

According to the coding manual, a participant's response was considered correct and coded as "1" if the performed step conformed to the description in the task analysis (quality), was initiated within eight seconds of the exercise directive or completion of the previous step in the task sequence (latency), and was completed within 15 seconds (duration). A participant's response was considered incorrect and coded as "0" when it did not meet the topographic, latency, and duration criteria (Yoder & Symons, 2010). The coding manual was piloted and used in previous studies with three adults with moderate ID (Obrusnikova, Cavalier, et al., 2019) and three adults with mild ID (Obrusnikova, Novak, et al., 2019). To ensure reliable coding of a participant's performance, inter-observer agreement (IOA) checks were completed for all observational data. IOA was calculated on a point-by-point basis by summing the number of agreements (i.e., when both observers indicated correct or incorrect performance of the step) and dividing it by the sum of agreements and disagreements. The observers were trained using a three-step training protocol described in Obrusnikova, Cavalier et al. (2019). The mean IOA percentages across all participants for the four exercise tasks were: preparation phase = 99% (range 94-100), execution phase = 97% (range 91-100), and clean-up phase = 100% (range 99-100).

Procedures

Participants were brought to the YMCA in groups of four by their case workers at consistent times between 9:00 a.m. and 1:30 p.m. The four participants (two from each group) participated in the exercise program and setting during the same time period, but their start times were staggered. The same instructor and research assistant (college exercise science juniors or seniors) worked with the participant. Instructors were asked to redirect attention of their participant or shield her/his view with their body if the participant attempted to observe the other participants during the session. At the end of the study, each participant received an incentive of their choice worth about $20. Partial completion resulted in a $10 incentive.

Treatment Fidelity and Social Validity

The study emphasized four key areas of treatment fidelity (i.e., establishment, assessment, evaluation, and reporting) as suggested by Perepletchikova and Kazdin (2005). Procedural fidelity checks were performed for all sessions using two fidelity checklists (i.e., one for each group) that were adapted from Obrusnikova, Novak et al. (2019). A trained research assistant who was also in charge of video recording evaluated either in-vivo or indirectly from the recordings the instructor's adherence to the prescribed procedures (20 components in the EG and 16 components in the CG) and her/his competence in delivering the instruction (8 components in the EG and 2 components in the CG) by checking each checklist's component as either present (coded as "1") or absent (coded as "0"). Adverse events or missed sessions were also recorded. Training of research assistants followed a protocol by Obrusnikova, Novak, et al. (2019), which covered strategies for working with adults with ID; information on maintaining confidentiality and procedural fidelity, and following the research protocol and instructional script. All instructors and research assistants were directly supervised by at least one investigator and had multiple opportunities to discuss participants. The supervisor independently observed (directly or indirectly) 50% of all sessions for each participant using the fidelity checklist. If the IOA fell below 90%, the instructor or the research assistant were provided feedback and, if necessary, additional practice. Fidelity agreement was calculated for each component, group, area of fidelity, and overall. For each level of analysis, the number of agreements were summed and divided by the total number of items in the checklist and then multiplied by 100%.

Consistent with Obrusnikova, Novak et al. (2019), two sets of social validity data were collected to determine social importance, acceptability, and contextual relevance of the intervention and the procedures. First, enjoyment of each session was assessed with the revised *Physical Activity Enjoyment Scale* (PACES; Motl et al., 2001), which in this study began with the stem: "When I exercised today…" followed by 16 statements such as "I enjoyed it," "my body felt good," and "it made me sad." Participants marked a five-point scale (1 = *Disagree a lot* to 5 = *Agree a lot*) with associated faces to indicate their response. A score was computed by averaging the ratings of 16 items, with low scores reflecting diminished participant acceptance.

To avoid confusion, “exercise” was defined for the participants as “everything you did in the session.” Validity of the revised PACES was assessed on a sample of children and middle-school aged girls (Moore et al., 2009; Motl et al., 2001). Second, following the last training session, the instructors, the research assistants, and the participant’ s job coaches completed an online social validity questionnaire. The questionnaire consisted of 15 seven-point rating items that were adapted from a well-cited social validity questionnaire measuring acceptability of the intervention (Elliott & Treuting, 1991).

Data Analysis

Statistical analyses of the participants’ performance data were conducted using the *Statistical Package for the Social Sciences* (SPSS) version 26.0 for Mac. Means, standard deviations, and mean differences were computed for each dependent measure and group. The two groups were examined at baseline for important demographic and clinical characteristics and to verify group homogeneity (Altman, Machin, Bryant, & Gardner, 2000). The results from Levene's test and the Box’s *M* test across the two groups indicated that homogeneity of variance was met for all four variables ($p > .05$). Results of a Shapiro-Wilk’s test were non-significant ($p > .05$) for all four variables. Further, a visual inspection of histograms, normal Q-Q plots, and box plots showed that the dependent measures were approximately normally distributed for both groups. Therefore, a 2 × 2 repeated-measures ANOVA was used to determine significance of the effect of the condition (EG vs. CG) and time on the performance of four resistance-training exercise tasks. Further, statistical significance of within-group changes from preintervention to postintervention was assessed with paired samples *t* tests. Statistical significance was set at an alpha level of $p < .05$. Partial eta squared (η_p^2) was computed for each effect (Altman et al., 2000). The magnitude of an effect size was interpreted according to Cohen (1988) as small

(.0099), moderate (.0588), or large (.1379). To our knowledge, no prior relevant studies have been conducted that would allow us to compute sample size for the hypothesis testing. Therefore, for a repeated-measures ANOVA, while applying a medium to large effect size (d = .60), a desired power of .80, and an α error of 5%, the minimum sample size was calculated to be 24 participants.

Results

Baseline Physical Structure and Function

An examination of means and standard deviations in Table 1 revealed that the two groups were similar in their baseline clinical measures (Altman et al., 2000). Using the WHO classification of obesity (2000), a majority (75%) of the sample had BMI scores in either the preobese (n = 8) or obese (n = 10) ranges and only six had normal weight. Of the 10 participants classified as obese, four had class I obesity, three class II obesity, and three class III obesity. The WASI-II FSIQ-4 scores indicated that 38% of the participants had cognitive abilities in the moderate range (six in the EG and three in the CG) and the remaining participants had cognitive abilities in the mild range (Wechsler, 2011). One participant in the EG and two participants in the CG were bilingual. The ROWPVT-4 age equivalent scores indicated that the receptive vocabularies and word comprehension of the participants were on average at 7-8 (SD = 1.33) years with the EG having slightly lower scores (M = 7-2, SD = 2.4) compared with the CG (M = 8-3, SD = 1.25). With the exception of one participant in the CG, UPST scores were well below the Bohannon et al. (1984) 30-second upper limit established for young adults. Given the 10-second standard established for stroke persons, about a half of the sample failed to meet it with eyes open while the entire sample failed to meet it with eyes closed. Participants in this study were able to perform the two functional performance tests (SMWT and SCT) safely, with only one participant with Down syndrome expressing discomfort when descending stairs. No participant had an SMWT score greater than the median SMWT score of 494 and 575 meters walked by healthy women and men, respectively (Enright & Sherrill, (1998).

Performance of Resistance-Training Exercise Tasks

Descriptive statistics associated with preintervention and postintervention performance in the two conditions are reported in Table 2. Mean within-group differences indicate that both groups improved their postintervention scores in the four exercises. Results of paired *t* tests (Table 2) showed that only the EG had statistically significant improvements in all four exercise tasks ($p < .05$). A two-way repeated measures ANOVA with a 95% confidence interval yielded significant main effects of the group by time in the performance of the chest press, $F(1, 22) = 6.26$, $p = .021$, $\eta_p^2 = .22$; leg press, $F(1, 22) = 6.78$, $p = .017$, $\eta_p^2 = .24$; seated row, $F(1, 22) = 5.76$, $p = .026$, $\eta_p^2 = .21$; and military press, $F(1, 22) = 6.06$, $p = .023$, $\eta_p^2 = .22$. Using the mastery criterion defined by Obrusnikova, Novak et al. (2019) (i.e., missing only two exercise steps in this study), the postintervention assessment data showed that of the 12 participants assigned to the EG, seven reached the mastery criterion in the chest press and eight in the leg press, seated row, and military press. Three of the 12 participants (Cody, Noah, and Levi; all pseudonyms) failed to meet the mastery criterion in all four exercise tasks. None of the CG participants reached the criterion.

Cody was a 19-year-old male with a co-morbid ID and autism spectrum disorder. The WASI-II test confirmed a mild ID (FSIQ-4 = 50, VCI = 45, PRI = 58). The ROWPVT-4 age equivalent indicated that his receptive vocabulary and word comprehension was 6-7 years. Results of the three function tests were below the sample's average (UPST = 5.46, SMWT = 382.9 m, SCT = 10.49 sec), mostly due to Cody's difficulties in following directions and staying focused during the assessment tasks. He also required frequent and more intrusive prompting during the familiarization sessions. During the first familiarization session, the instructor had to apply a physical prompt to an average of 38% of steps across the four exercise tasks. He required no physical prompting during the last familiarization session. Unlike most other participants, Cody's PACES scores did not always indicate that he accepted or enjoyed the intervention (*M* = 3.19; range = 2.66-4.00 out of 5). His lowest rated PACES item was, "It felt good."

Levi was a 44-year-old male with a mild ID (FSIQ-4 = 41, VCI = 48, PRI = 43). The ROWPVT-4 age equivalent score was 5-8 years. Levi's function tests scores also were below the sample's average (UPST = 4.97 sec, SMWT = 353.9 m, SCT = 12.79 sec). During the first familiarization session, the instructor had to apply a physical prompt to an average of 46% of steps across the four exercise tasks. He still required a physical prompt to 23% of steps during the last session. Furthermore, Levi struggled to apply an appropriate amount of pressure to the screen, which then required the instructor to physically hold Levi's finger when using the VAS.

Noah was a 31-year-old male with a moderate ID (FSIQ-4 = 46, VCI = 55, PRI = 45). His ROWPVT-4 age equivalent score was 8-8 years. Noah's function was within the sample's average (UPST = 24.84 sec, SMWT = 439.3 m, SCT = 7.64 sec), but the UPST and SMWT scores were below the normative data (Bohannon et al., 1984; Enright & Sherrill, 1998). During the first familiarization session, the instructor had to apply a physical prompt to an average of 32% of steps across the four exercise tasks. Similar to Cody's performance, he required no physical prompting during the last session. However, he still required more intrusive prompts to perform the preparation steps. One explanation of Levi and Noah's relative prompt-dependency is that they both struggled to identify letters of the alphabet or numbers, which made it difficult for them to read information in the exercise log, set the machines, operate the iPad, and use the

VAS. Even with help from the instructor, they both rated most of the PACES items as 5 out of 5.

Detailed analyses of performance of individual steps in the EG during the three phases of each exercise after the intervention revealed that the preparation steps were the most challenging for participants to perform correctly and independently (*M* = 74% of all preparation steps, but especially the setting-the-weight step), followed by the execution steps (77%) particularly in the seated row and military press. Participants required frequent prompts to avoid releasing or banging the weights at the end of each repetition and when moving free weights overhead. The clean-up steps were the easiest for participants to perform (93%). While participants in the CG demonstrated small mean gains in their performance of preparation (20%) and clean-up steps (6%), which could have been due to observation of the instructor completing those steps for them, they demonstrated 5% loss in their performance of execution steps.

Procedural Fidelity and Social Validity

No participants withdrew from the study. Missed sessions were made up by attending an extra day in the same or following week. Missed sessions were due to illness that was unrelated to the training program. Fidelity scores were calculated across all sessions and participants within each group (i.e., 72 observations in each group). The overall procedural fidelity scores were 99% (range = 92-100) in the EG and 99% (range = 94-100) in the CG. Component analysis revealed that, on average, all fidelity components were rated above 90%. The instructors' procedural adherence average scores were 100% (range = 94-100) in the EG and 99% (range = 93-100) in the CG. Average scores for the instructors' competence to deliver instruction were 98% (83-100) for the familiarization sessions and 100% for the control-group sessions. The following component had the lowest average instructor competence score (91%): "instructor prompts using the SLMP hierarchy starting with a verbal prompt, then a video, a gestural, and a physical prompt." Notes in the checklists revealed that in five instances, the instructors skipped the video prompt and went straight to a gestural prompt. Still, it was concluded that both the intervention and the control conditions had a high degree of procedural fidelity; that is, the intervention components were correctly implemented and consistently followed according to the procedural manual across sessions, participants, and the two groups (Perepletchikova & Kazdin, 2005).

Using a seven-point social validity scale (Elliott & Treuting, 1991), the instructors, the research assistants, and the participants' job coaches rated the EG Condition more acceptable ($M = 6.60$, $SD = .19$) compared with the CG Condition ($M = 5.36$, $SD = 0.57$). Likewise, using the five-point PACES scale (Motl et al., 2001), participants in the EG found the intervention slightly more enjoyable ($M = 4.85$, $SD = .25$) compared with the CG ($M = 4.75$, $SD = .30$).

Discussion

The results of this study support our hypothesis that adults with ID who received a six-session multi-component familiarization intervention, consisting of a VAS and a video-enhanced SLMP both displayed via an iPad, will correctly and independently perform a significantly greater number of steps of four resistance-training exercise tasks compared with participants who did not receive such a training intervention, relative to their preintervention performance, in a community fitness center. All participants in the EG improved their performance of the four resistance-training exercise tasks, which was not the case in the CG. The effect sizes indicate large effects of the intervention for all exercise tasks (Cohen, 1988). The results of this group design study concur with results of previously published single-subject design studies (Obrusnikova, Cavalier, et al., 2019; Obrusnikova, Novak, et al., 2019), which concluded that the video-enhanced SLMP substantially facilitated acquisition and maintenance of resistance-training exercise tasks in three young adults with moderate ID (in a self-contained room) and three young adults with mild ID (in a small fitness room). Clearly, the VAS and the different prompt levels within the video-enhanced SLMP are consistently proving to be effective in promoting correct and independent performance of resistance-training exercise tasks in adults with ID in a variety of exercise settings.

While these findings are encouraging, some participants in this study required a high frequency and intensity of prompting when performing steps during the preparation phase of each exercise task, particularly to set the weight, the seat height, and the pad/platform position. Interestingly, participants in two single-subject design studies (Obrusnikova, Cavalier, et al., 2019; Obrusnikova, Novak, et al., 2019), struggled primarily with steps in the execution phase of each exercise task. Additionally, similar to those two single-subject design studies, not all participants in the current study reached mastery of the four exercise tasks after six familiarization sessions. The three (out of 12) participants who failed to meet the criterion in all four tasks had body composition in the preobese or obese ranges and had more significant impairments in cognitive abilities, receptive language, static balance, and functional performance. In addition, two of them could not identify letters of the alphabet or numbers and needed frequent physical prompting even after six familiarization sessions.

The environment plays an integral role in the ICF framework (Schneidert, Hurst, Miller, & Üstün, 2003). The person and the environment are in a constant state of interplay, such that demands on a person's functional capabilities are continually changing based on the contextual factors that are present (McDougall et al., 2010). Community fitness centers typically impose greater task-related and environmental demands on the functional capabilities of persons with ID (Rimmer et al., 2017) compared with self-contained settings. A person's functioning in a fitness center can be enhanced when the person–environment mismatch is reduced (Thompson et al., 2009). Persons with limited capabilities and adaptive behaviors may need different types and intensities of support to promote their independent performance of more complex exercise steps (e.g., stretch legs but not all the way) or their generalization of steps across different settings or machines (e.g., using different weight-adjusting mechanisms across different machines). Therefore, assessing only intellectual and physical capabilities most likely will not be sufficient if the person's goal is to achieve functional independence (McDougall et al., 2010; Schalock et al., 2010; Thompson et al., 2016).

To help researchers and practitioners determine the person's unique support needs and set person-centered goals, the process also should involve assessing a person's interests, personal preferences, and adaptive capabilities, along with the environmental demands of the fitness center. Thomson et al. (2016) identified three classes of support resources and strategies that researchers can use to increase the efficiency and effectiveness of familiarization programs in future studies: people (e.g., natural supports such as peers, trained personal trainers, and wellness instructors), technology (i.e., instructional and assistive), and adaptations (e.g., changes to the goals, instructional delivery, instructional materials, equipment, and exercise tasks). Consistent with the ICF, each person has unique strengths and limitations in personal competency and no two fitness environments are exactly the same. Conceptual frameworks that focus on a person's strengths shift the focus from what a person with ID cannot do because of her/his structural or functional impairments to what they can do with the right system of supports. In this view, supports should compensate for skill limitations, build on personal strengths, and account for environmental expectations and conditions (Thompson et al., 2016).

Correct performance of resistance-training exercise tasks is paramount for prescribing safe and effective resistance-training intensities and evaluating efficacy of resistance training programs (ACSM, 2009; Bocalini et al., 2013; do Nascimento et al., 2013). Providing an accurate assessment of submaximal or maximal strength, such as the estimated or actual one-repetition maximum (1RM), is important for determining baseline levels for resistance training programs (do Nascimento et al., 2013). However, limited evidence exists regarding the validity of these measures or the use of familiarization protocols during resistance training programs and fitness testing (Rintala, McCubbin, & Dunn, 1995). Findings in this study confirm that after two familiarization sessions the participants did not master the positioning and execution steps of the four exercise tasks, which are often used in 1RM testing. In fact, the participants in CG, who performed the exercise tasks without instruction and familiarization, did not improve and in some cases declined in their performance after six familiarization sessions. This is problematic because growing evidence suggests that 1RM scores can be substantially influenced in the first few familiarization sessions by extrinsic aspects such as a participant's motivation, exercise task performance, overall experience, increased motor unit recruitment and capacity to tolerate maximal loads, and decreased coactivation of antagonist muscles during the execution (Bocalini et al., 2013; do Nascimento et al., 2013; Griffin & Cafarelli, 2005). Researchers and practitioners who prescribe training intensity to adults with ID are encouraged to implement familiarization sessions prior to 1RM testing or initiating a resistance training program (Bocalini et al., 2013; do Nascimento et al., 2013) to ensure safety, accuracy, and effectiveness. Research is needed to determine the relationship between familiarization time and stabilization of 1RM results.

A strength of this study is that all exercise sessions were supervised, video-recorded, and coded to ensure fidelity and provide immediate feedback to instructors. Because participants were required to complete all sessions, compliance with the exercise routines was not a limitation. When interpreting the results, three limitations of the study need to be considered. First, participants' exercise behavior could have been influenced by video observation and measurement, i.e., the Hawthorne effect. Second, the study lacked blinded observers to collect data at pre- and post-intervention periods. Third, the study did not include follow-up data collection, which made it difficult to determine whether the participants were able to independently use the VAS and maintain high level of performance of the exercise tasks after the six-week familiarization intervention. Future research should investigate how long these acquired tasks are maintained after assistance is removed. Researchers also could look at the relative contributions of the different components of the familiarization intervention (i.e., the VAS and the different prompt levels within the video-enhanced SLMP) to the overall outcomes for the participants. It would be interesting to explore how much of the outcomes can be attributed to those components in isolation. It also might be valuable to explore the relative value of the VAS vs. the SLMP for different participants. Nevertheless, these data provide encouraging support for inclusion of the familiarization intervention presented in this study as part of progressive resistance training programs for adults with ID.

In conclusion, to our knowledge, the present study is the first to use a group design to demonstrate the effects of a multi-component familiarization intervention on functional performance of resistance-training exercise tasks in adults with ID in a community fitness center. The results suggest that the VAS and the video-enhanced SLMP delivered via an iPad can effectively improve correct and independent performance of resistance-training exercise tasks in adults with mild to moderate ID. VAS and video-enhanced prompting systems are promising intervention strategies for researchers, personal trainers, teachers, and coaches to not only promote learning of resistance-training exercise tasks and functional independence among adults with ID but also establish consistent and reliable strength measures. The mismatch between a person's capabilities and performance of fitness tasks while facing the demands of a fitness setting provides a useful guide for identifying the appropriate type and intensity of support to address the unique needs of each adult with ID. By improving the capabilities of adults with ID to manage their own exercise behavior while reducing their dependence on other persons, we can overcome some of the longstanding constraints to their maintenance of healthy levels of physical fitness and physical activity, which can further benefit them in the recreational and vocational areas of their lives. Findings of this study also highlight the importance of implementing familiarization sessions before researchers or practitioners carry out 1RM testing or initiate a resistance training program to ensure safety, accuracy, and effectiveness of the program for adults with ID.

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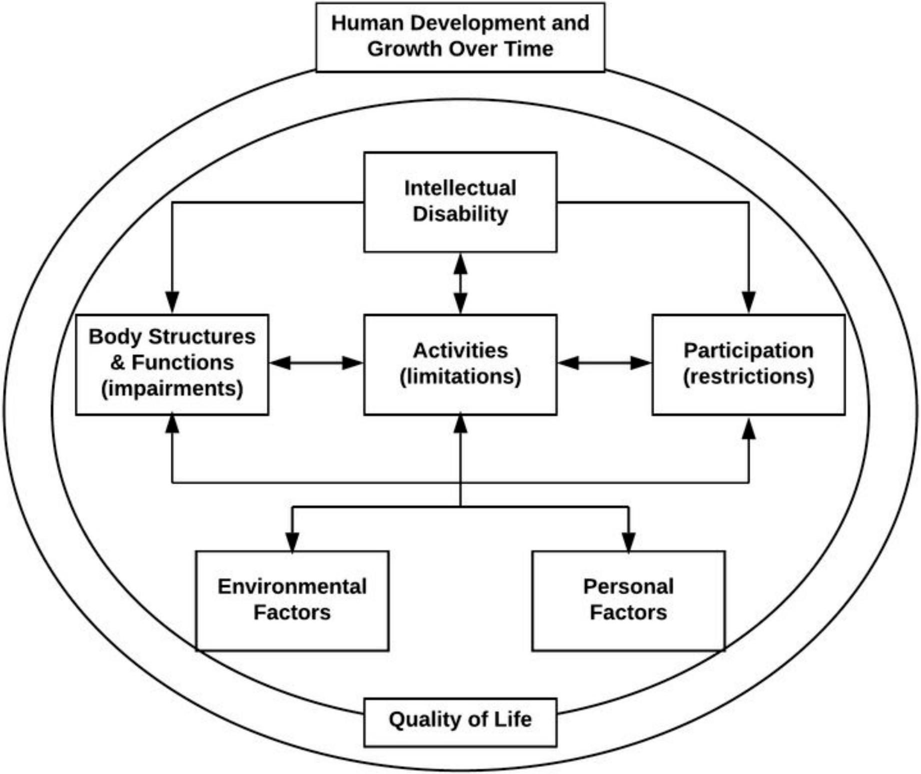
Figure 1. A modified version of World Health Organization's model of functioning and disability. Adapted from McDougall, Wright, and Rosenbaum (2010).

Figure 2. Study design and number of participants at each stage of the experimental study.


Human Development and Growth Over Time
Intellectual Disability
Body Structures & Functions (impairments)
Activities (limitations)
Participation (restrictions)
Environmental Factors
Personal Factors
Quality of Life

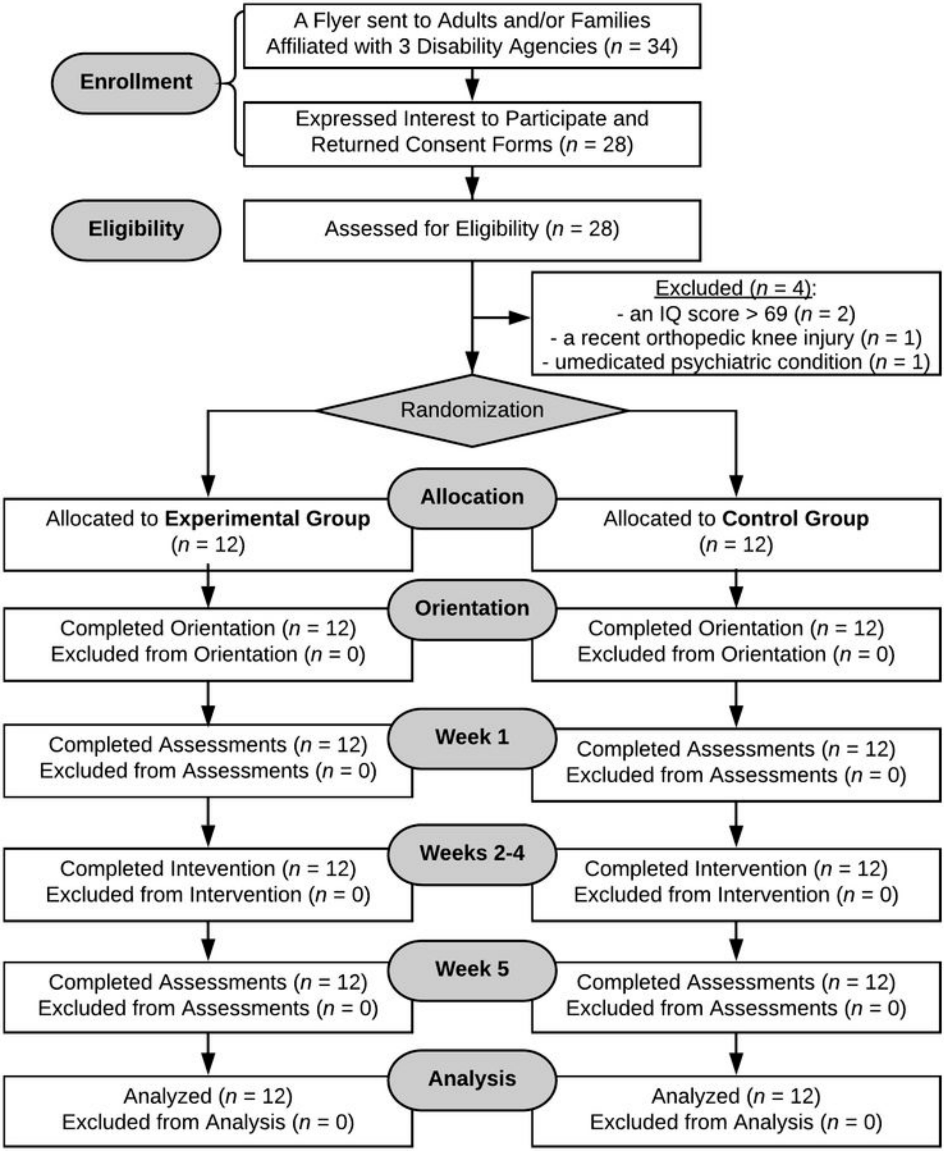

Enrollment
A Flyer sent to Adults and/or Families Affiliated with 3 Disability Agencies (n = 34)
Expressed Interest to Participate and Returned Consent Forms (n = 28)
Eligibility
Assessed for Eligibility (n = 28)
Excluded (n = 4):
- an IQ score > 69 (n = 2)
- a recent orthopedic knee injury (n = 1)
- umedicated psychiatric condition (n = 1)
Randomization
Allocation
Allocated to Experimental Group (n = 12)
Allocated to Control Group (n = 12)
Orientation
Completed Orientation (n = 12)
Excluded from Orientation (n = 0)
Completed Orientation (n = 12)
Excluded from Orientation (n = 0)
Week 1
Completed Assessments (n = 12)
Excluded from Assessments (n = 0)
Completed Assessments (n = 12)
Excluded from Assessments (n = 0)
Weeks 2-4
Completed Intevention (n = 12)
Excluded from Intervention (n = 0)
Completed Intervention (n = 12)
Excluded from Intervention (n = 0)
Week 5
Completed Assessments (n = 12)
Excluded from Assessments (n = 0)
Completed Assessments (n = 12)
Excluded from Assessments (n = 0)
Analysis
Analyzed (n = 12)
Excluded from Analysis (n = 0)
Analyzed (n = 12)
Excluded from Analysis (n = 0)

Table 1.

Participant Baseline Characteristics of the Experimental Group (n = 12) and the Control Group (n = 12).

Variable	Experimental Group			Control Group		
	M	*SD*	Range	*M*	*SD*	Range
Age (years)	26.42	7.66	19-44 years	22.75	7.24	18-44 years
FSIQ[a]	51.17	9.62	41-69	55.33	8.95	41-69
VCI[a]	57.33	14.71	45-94	56.42	10.30	45-81
PRI[a]	51.58	6.90	43-66	59.67	11.16	45-81
ROWPVT	88.08	23.10	49-123	96.42	23.16	55-139
Body Mass Index (kg/m^2)	31.10	9.40	22.37-50.21	29.70	6.61	18.83-39.63
UPST (sec)	10.39	9.23	.05-30.00	11.93	10.09	.40-29.16
UPST-closed eyes (sec)	2.38	2.12	.58-8.92	2.07	1.32	.10-5.31
Stair Climb Test (sec)	9.82	3.24	6.15-14.93	9.06	2.80	5.47-13.69
Six-Minute Walk Test (m)	444.9	62.97	353.9-552.7	451.3	105.2	253.8-597.3

Note. FSIQ = WASI-II's Full Scale Intellectual Quotient composite score on the WASI-II; PRI = Perceptual Reasoning score on the WASI-II; VCI = Verbal Comprehension Index composite score; PRI = Perceptual Reasoning Index composite score; ROWPVT = Receptive One-Word Picture Vocabulary Test-Fourth Edition raw score; UPST = Unipedal Stance Test.

[a]Confidence interval = 95%. A composite score <70 indicates extremely low ID.

Table 2

Preintervention, Postintervention, and Change Scores for Four Muscle-Strengthening Exercises and Two Physical Function Tests for the Experimental and Control Groups

Group	Preintervention			Postintervention			Change		
	M	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	*t*
Chest Press [a]									
Experimental	6.09	2.55	2-10	15.45	2.98	8-18	9.36	1.63	19.06*
Control	7.67	3.08	2-12	8.25	2.63	3-13	.58	1.73	1.17
Leg Press [a]									
Experimental	6.09	3.02	2-10	15.27	2.94	8-18	9.18	2.18	13.95*
Control	7.33	2.67	2-11	8.33	2.67	4-12	1.00	2.00	1.73
Seated Row [b]									
Experimental	5.64	3.47	1-10	16.00	4.58	7-19	10.36	3.35	10.25*
Control	7.25	3.31	2-13	7.67	3.06	3-12	.42	2.11	.68
Military Press [b]									
Experimental	4.64	3.32	0-11	16.09	3.42	9-19	11.45	3.27	11.63*
Control	6.92	2.91	2-12	7.58	3.53	2-14	.67	1.83	1.27

* $p<.01$.

[a] Out of 18 chained steps; [b] out of 19 chained steps.