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UNIVERSITY OF MIAMI

ADL-SPECIFIC VERSUS STANDARD AQUATIC EXERCISE IN OLDER PERSONS

By

David A. Edwards

A DISSERTATION

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Doctor of Philosophy

Coral Gables, Florida

June 2011

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ADL-Specific Versus Standard Aquatic Exercise In Older Persons (June 2011)

Abstract of a dissertation at the University of Miami.

Dissertation supervised by Professor Joseph Signorile.
No. of pages in text (27)

With aging there is a decrease in a person's ability to perform activities of daily living (ADL) which may be most effectively addressed using training patterns that are biomechanically similar to ADL. Since aquatic exercise offers the opportunity to provide resistance with a high level of safety, the pool may afford the ideal environment for ADL-specific training in an aging population. **Purpose:** The purpose of this investigation was to compare a traditional aquatic exercise program (TRAD) to an aquatic program tailored to target ADL (ADL_{spec}). **Methods:** Eighteen independently living individuals (68.7 $\pm$ 7.5 years) were randomly assigned to a TRAD or ADL_{spec} aquatic exercise group. The exercise groups attended 1 hr exercise sessions, 2 times per week for 8 weeks. ADL ability was assessed using the short version of the Continuous-Scale Physical Functional Performance Test (PFP-10); while strength and power were assessed using the 30s arm curl and 30 sec. chair stand tests. **Results:** Mixed design ANOVAs revealed a significant group x time interaction for floor sweep time with the ADL_{spec} group outperforming the TRAD and control (CON) groups ($p = .043$). Additionally, the ADL_{spec} group improved the pan weight and scarf time components of the PFP-10 ($p < .020$), while the TRAD group improved pan time and laundry time ($p < .046$). Both training groups showed similar improvements for jacket time, grocery weight, and 6-min walk, ($p < .046$). The ADL_{spec} and TRAD groups also made similar improvements in upper and lower body strength, as well as lower body power across time, ($p < .043$). A student's *t*-test revealed the TRAD group spent more time exercising during the hour session than the ADL_{spec} group ($p < .05$). **Conclusion**: The results indicate that performing an ADL_{spec} aquatic exercise program can increase performance of ADL that require more complex sequential movements; however, ADL more dependent on fitness may be better addressed using a TRAD intervention. These results can be helpful when designing a periodized aquatic training program to increase independence in older persons.

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Chapter 1

Introduction

The number of persons aged 65 and older is progressively increasing as the Baby Boomer generation ages and medical advancements prolong life expectancy. The United States Census Bureau reported an estimated 37 million elderly persons in the U.S. in the year 2006; and estimates that within the next four decades this segment will reach over 80 million representing more than 20% of the population (Aging Stats.gov/Population). This increase in the number of older persons presents unique challenges that will need to be addressed on both societal and individual levels. For example, elderly individuals account for a greater use of medical services than any other age-defined segment of the population, an average per capita cost of $15,081 per year (Aging Stats.gov/Health care). A large portion of this cost is paid by the American taxpayer with Medicare or Medicaid paying 62% of the average yearly healthcare costs. On a more personal level, older persons and their families must often make up the difference between their benefits and actual costs, placing a substantial financial burden on lower- and middle-income families. In addition to the economic burdens associated with aging, there are also emotional burdens due to reductions in quality of life, decreased independence and loss of social interactions (Hyde, Wiggins, Higgs, & Blane, 2003).

Research has demonstrated the positive impact that exercise interventions can have on the physical declines associated with aging (Bean et al., 2004; Bocalini, Serra, Murad, & Levy, 2008; P. L. de Vreede et al., 2004; Hazell, Kenno, & Jakobi, 2007; T. R. Henwood, Riek, & Taaffe, 2008; Hornbrook et al., 1994; Sato, Kaneda, Wakabayashi, & Nomura, 2007; Sato, Kaneda, Wakabayashi, & Nomura, 2009; Signorile et al., 2002).

Moreover, exercise has been shown to be an effective tool for improving individuals' mood state, as evidenced by reductions in the level of depression by older persons who exercise on a regular basis (Deslandes et al., 2009; Wang, Belza, Elaine Thompson, Whitney, & Bennett, 2007).

Training specificity, which states that the physiological and biomechanical adaptations to exercise are dictated by the nature of the training overload, is a cornerstone for exercise intervention (Wilmore & Costill, 2004). It follows, therefore, that if an exercise prescription is to maximize benefits it should utilize movement patterns that reflect the targeted task (Baechle & Earle, 2000). Based on this concept, programs designed to increase functionality in an aging population, should incorporate patterns of movement used during activities of daily living (ADL) and instrumental activities of daily living (IADL).

Regrettably, few exercise studies involving older persons have incorporated the principal of biomechanical specificity (P. de Vreede L., Samson, van Meeteren, Duursma, & Verhaar, 2005; P. de Vreede L. et al., 2007; P. L. de Vreede et al., 2004; Sato et al., 2007; Sato et al., 2009); however, a limited number of studies has demonstrated that programs which mimic ADL function are well tolerated, effective, and can lead to improved exercise adherence (P. L. de Vreede et al., 2004). Additionally, ADL-specific exercise programs appear to have the potential to increase ADL functionality to a greater extent than traditional resistance-training programs (P. de Vreede L. et al., 2005).

Aquatic exercise, an activity with a high number of older participants, has grown in popularity from 5.8 million practitioners in 2004 to 7.2 million in 2007 (Becker &

Cole, 2003). This mode of exercise has been used as a therapeutic intervention for a variety of ailments such as osteoarthritis, fibromyalgia, and multiple sclerosis (Hinman, Heywood, & Day, 2007; Salem et al., 2011; Tomas-Carus et al., 2009) and research indicates that aquatic exercise can reduce age-related declines in functionality (Cochrane, Davey, & Matthes Edwards, 2005; Foley, Halbert, Hewitt, & Crotty, 2003; Sato et al., 2007; Sato et al., 2007; Sato et al., 2009; Suomi & Collier, 2003). Water-based exercise also offers a number of unique benefits to older persons due to the aquatic environment including: reduced probability of injury if an accidental fall or stumble should occur, decreased joint loading, and increased fluid resistance (Stemm & Jacobson, 2007). The first benefit, reduced probability of injury due to a fall or stumble, is particularly important as fear of falling is one of the major barriers to exercise in an aging population (Lees, Clarkr, Nigg, & Newman, 2005); while decreased joint loading reduces the likelihood of connective tissue damage (Colado et al., 2010; Konlian, 1999). Finally, increased fluid resistance and the non-linear relationship between velocity and drag force make the pool a safe and effective environment for the high-speed resistance training programs most effective at improving speed and power in older individuals.

To date only two studies have applied the principle of ADL biomechanical specificity to aquatic training (Sato et al., 2007; Sato et al., 2009). Both studies followed identical exercise protocols that incorporated a brief ten-minute ADL-specific exercise component as part of a traditional one-hour training program (Sato et al., 2007; Sato et al., 2009). These studies showed improvements in quality of life, bathing transfer tasks, and stair climb time in a frail aging population over 6 and 24 month of training, respectively (Sato et al., 2007; Sato et al., 2009).

The purpose of our study was to compare the improvements in ADL function, strength, and power resulting from a traditional aquatic exercise program (TRAD) versus an ADL-specific aquatic exercise program (ADL_{spec}). A unique aspect of this study was the nature of ADL-specific exercise protocol, which utilized common household items for performing ADL- and IADL-specific movements at high speeds to improve power and ADL performance. It was hypothesized that both aquatic exercise programs would significantly improve strength, power, and functionality over the control group (CON); and that the ADL_{spec} program would improve ADL performance to a greater degree than TRAD training.

Chapter 2

Methods

Participants.

Eighteen independently living men and women (68.7 ± 7.5 years) took part in this study. To qualify for the study participants needed to be injury-free at the start of enrollment, be 50 years of age or older, and not have been participating in any structured exercise program for the past year. Participants were solicited using flyers posted throughout the university and surrounding areas, and through an advertisement placed in a local newspaper. Participants were screened during an initial phone interview to determine their eligibility and were subsequently provided an appointment if they qualified. During the initial appointment participants signed an informed consent form approved by the University's Subcommittee for the Protection and Use of Human Subjects and were then randomly assigned to one of three groups: TRAD, ADL_{spec}, or CON.

Training.

The intervention portion of the study lasted eight weeks and classes were offered twice per week and were one-hour in duration. Aquatic fitness instructors with two years of experience led both aquatic exercise programs. The ADL_{spec} exercise class was developed by the research team in collaboration with the aquatic exercise instructors.

The TRAD exercise group followed a standard aquatic exercise program commonly offered for older persons in most fitness facilities. The program included a warm-up period, followed by a cardiovascular and strength training period, and finally a cool down period. The warm-up period included low-intensity dynamic activities and stretching to increase the temperature of the muscles and range of motion of the joints, respectively. Cardiovascular training included rhythmic upper and lower body movements designed to elevate participants' heart rates, while the strength-training portion targeted the major upper and lower body muscle groups using variations in hand position, standard drag and resistance devises and movement speed to increase exercise intensity. The cool-down period included low-intensity body movements and stretching.

The ADL_{spec} group's workout also included three phases. The warm-up and cool-down phases were similar to those used during the TRAD program. In contrast, the exercise component incorporated movements that mimicked ADL such as climbing stairs, rising from a chair, sweeping, transfer of pots and pans, loading and unloading laundry, putting on clothing, multi-directional walking, picking up objects from the floor, and loading and unloading groceries. The ADL_{spec} exercise intervals were performed at progressively faster speeds throughout the study period to target both muscular power and movement speed.

The persons in the CON group were given the option of receiving literature and presentations concerning the positive effects of exercise and were instructed to maintain their regular daily routines and not begin any formal or informal exercise programs during the study period.

Performance Testing.

Prior to and following the eight-week exercise intervention, measurements were taken to determine participants' ADL function, lower body strength and power, and upper body strength.

Activities of Daily Living. The Ten-Item Physical Function Performance Battery (PFP-10) was used to assess ADL performance (Cress, Petrella, Moore, & Schenkman, 2005). Tasks included the transfer of a weighted pan from one table to another, sweeping, picking up scarves, donning and doffing a jacket, simulated shopping, climbing a flight of stairs, reaching overhead for a small object, sitting down and rising from the floor, transferring laundry from a washer and dryer to a shelf, and a 6 min walk.

Lower Body Strength and Power Testing. A 30s chair stand test, as described by Rikli and Jones (1999), was used to evaluate lower body strength. Briefly described, the participant was asked to perform as many unassisted chair stands as possible within a 30s time period while his or her arms remained folded across the chest. Chair stands completed in the first 20s of the test were used to compute lower body power using the equation developed by Smith et al. (2011).

Upper Body Strength Test. The 30s arm curl test was used to assess upper body strength (Rikli & Jones, 1999). The participant sat in a straight back armless chair with an 8 lb. (men) or 5 lb. (women) weight in his or her hand. The participant then curled the weight as many times as possible in 30s.

Statistics.

Mixed design analyses of variance (3 group x 2 time) (ANOVA) were used to examine differences in variables between groups over time. The sources of significant time effects or group x time interactions were determined using LSD *post* hoc tests. A Student's *t*-test was used to determine any between-group differences in actual time spent exercising within a training session.

Chapter 3

Results

Anthropometric Data

The three-way ANOVA on baseline anthropometric data revealed significant differences for height, (p = .40). As displayed in Table 1, *post hoc* analysis revealed the TRAD group was taller than the ADL_{spec} and CON groups, (p < .029). There were no group differences for age or body weight.

Baseline Performance Data

The examination of baseline performance variables using the three-way ANOVA, revealed a significant difference between groups for sponge reach test, (p = .022). After controlling for participants' heights using an ANCOVA analysis, baseline differences in sponge reach were no longer detected.

PFP-10

The mixed design ANOVA showed a time x group interaction for floor sweep (p = .043). *Post hoc* tests indicated that the ADL_{spec} and TRAD groups improved floor sweep performance across the training period (p = .045). As shown in Table 2, the analysis also revealed that the ADL_{spec} group performed significantly better than the TRAD and CON groups at the end of the training period (p < .018).

The ANOVA further revealed time main effects for pan time, pan weight, jacket time, scarf time, laundry time, grocery time, and 6 min walk (p < .046). LSD *post hoc* tests showed that the ADL_{spec} and TRAD groups improved, jacket time, grocery weight, and 6 min walk (p < .020). Post hoc analyses also indicated that improvements in pan weight and scarf time were restricted to the ADL_{spec} group; while only the TRAD group improved pan time and laundry time ($p < .046$). A trend for a significant group x time interaction favoring the TRAD group was seen for the 6 min walk ($p = .075$).

Strength and Power

The mixed ANOVA examining lower body strength detected a significant main effect for time for the 30s chair stand ($p = .001$). *Post hoc* tests indicated that the ADL_{spec} and TRAD groups showed similar increases in chair stand repetitions ($p = .033$). The mixed design ANOVA examining lower body power revealed significant main effects for time in lower body peak power (LBPP), lower body average power (LBAP), and lower body peak and average power per kg body weight (LBPP/kg, and LBAP/kg ($p < .002$). As shown in Table 3, *t*-tests revealed that the ADL_{spec} and TRAD groups showed the same levels of improvement on all measures of lower body power ($p < .043$). No improvements in these variables were detected for the CON group. The effect sizes for pretest to post-test changes for 30s chair stand, LBPP, LBAP, LBPP/kg and LBAP/kg were small to medium for both training groups.

The mixed design ANOVA examining upper body strength showed a time x group interaction for 30s arm curl, ($p = .011$). Independent samples post hoc *t*-tests, however, revealed significant improvements in both the ADL_{spec} and TRAD groups ($p < .024$) and no group differences at any time point. Further analysis using an ANOVA to analyze difference in change scores across the training period revealed no significant difference between the ADL_{spec} and the CON or TRAD groups. A significant difference was seen between the TRAD and CON ($p = .024$). The effect size for pretest to post-test changes for 30s arm curl was medium to large ($d = .66$) for the ADL group and large ($d = 1.63$) for the TRAD group.

Finally, the student's *t*-test revealed that the TRAD group spent more time engaged in actual exercise activity during each class session than the ADL_{spec} group (p = .042).

Chapter 4

Discussion

To our knowledge this is the first study to implement an ADL-specific aquatic exercise intervention in an independently-living community-dwelling elderly population; although, ADL-specific exercises were included in aquatic training programs studied by Sato et al. when examining a frail older sample (2007; 2009). The main finding of the current investigation was that the ADL-specific aquatic exercise program had the potential to improve upper body strength and lower body strength and power to a similar degree as a traditional aquatic training program in this population using significantly less exercise time per training session. Additionally, our findings indicate that specific ADL and IADL, which require multi-joint sequential movement patterns, may be addressed more effectively through ADL-specific training; while other daily activities which incorporate less complex patterns might be equally well, if not more effectively addressed, using simpler training patterns that primarily target fitness parameters.

Our results, indicating that ADL-specific training is more effective at improving ADL performance than a standard aquatic exercise program, are similar to those reported by Sato et al. (2007; 2009) who reported that their ten-minute ADL-specific transfer practice significantly improved transfer skills in their frail older individuals. The results also reflect those reported by deVreede et al. (2005; 2007; 2004) during land-based interventions showing a greater potential for improving ADL performance using biomechanically-specific ADL tasks rather than traditional weight-training. In examining the results of the three tests that favored the ADL_{spec} group, it can be argued that these tests require the use of a specific sequential firing pattern for maximal performance. For example, the ADL_{spec} group produced significantly greater improvements than the TRAD and CON groups for the floor sweep test. As can be seen in Table 4, which outlines the activities performed by the ADL_{spec} group, exercises using sweeping movements and brooms were frequently incorporated into the class structure. During these exercises participants were asked to hold the broom handle in a similar fashion to a sweeping task and to rotate at the waist thereby mimicking the ADL. While the TRAD group performed a variety of exercises that targeted the upper body musculature and rotation at the waist, these exercises did not employ the sequential movement patterns used during sweeping.

The significant improvement in scarf pick-up time made by the ADL_{spec} group, not seen in the TRAD group, also argues for the effectiveness of ADL-specific training. During the training sessions the ADL_{spec} group performed exercises where objects were retrieved from the pool bottom, a movement that was biomechanically similar to picking up the scarves from the ground. Once again, although components of this movement pattern were performed during TRAD training, such as bending at the waist during abdominal leg raises, the complete kinetic chain of the movement unique to the scarf pick-up test was performed only during ADL_{spec} training.

The different patterns of improvement seen in the ADL_{spec} and TRAD groups for the pan carry test may also reflect the impact of exercise specificity on performance. In the development of the PFP-10, Cress et al. (2005) suggested that tasks using weight as an outcome variable primarily assess muscular strength, while the timed tasks reflect speed, balance and coordination. The results showing the ADL_{spec} group increasing the pan-carry weight, while the TRAD group decreased pan-carry time, may reflect load and velocity specificities as they relate to the respective tasks. In their study examining the effects of muscular power and force on gait speed, Cuoco et al. (2004) reported that power output at 40% of 1RM explained more of the variability in habitual gait velocity than power output at 70% of 1RM. These results support the postulate that the levels of improvement in force and velocity can be dictated by the loading pattern used, and therefore the location of the training stimulus along the force-velocity curve. Since many ADL_{spec} drills used activities designed to increase drag forces, like moving a 69cm x 46cm laundry basket through the water, while the TRAD group used more conventional devises which offer considerably less drag, it may be that the increases in pan load and decreases in pan time by the ADL_{spec} and TRAD groups, respectively, are reflections of the load/velocity specificities of their training as they relate to transfer tasks

Our results showed that the TRAD and ADL_{spec} training produced similar improvements in jacket don and doff time, grocery carry time, and 6-min walk distance. Performance of the jacket don and doff test is reflective of upper body flexibility. The fact that both groups incorporated brief flexibility training periods during the cool down phase of *each* exercise session and performed the majority of their exercises through the full range of motion may explain the similarity in these results. The comparable improvements in the two training groups for grocery carry time and 6-min walk are expected since both training protocols incorporated exercises that should positively impact neuromuscular and cardiovascular endurance. The fact that these tests use simple motor patterns, rather than the more complex patterns associated with the scarf pick-up and sweeping tasks, offers one explanation for the similar changes in the TRAD and ADL_{spec} groups. The trend seen toward better performance by the TRAD group on the

6-min walk test may be due the greater concentration on producing physiological, rather than biomechanical, changes during the TRAD training protocol.

As reported in previous aquatic exercise studies, both training programs used in the current study demonstrated the ability to positively impact muscular strength (Bocalini et al., 2008; Foley et al., 2003; Tsourlou, Benik, Dipla, Zafeiridis, & Kellis, 2006). The fact that the ADL_{spec} group showed similar improvements to the TRAD group in 30s arm curl and 30s chair stand tests was somewhat unexpected, since the TRAD group performed a greater number of strength-training tasks isolating specific muscle groups than the ADL_{spec} group. However, it appears that the ADL-specific tasks, many of which concentrated on moving objects with moderate to large surface areas at high speeds, provided sufficient overload to produce strength gains similar to those seen with the more isolated movements used during TRAD training.

The similar improvements made in muscular power by each training group were also unexpected. The majority of the research examining the most effective way to increase older persons' power outputs has utilized high-speed movement patterns similar to those emphasized during the ADL_{spec} protocol (Fielding et al., 2002; T. R. Henwood & Taaffe, 2005; Hruda, Hicks, & McCartney, 2003; Signorile et al., 2002), and recent studies have demonstrated that the performance of high-speed plyometric exercises is as effective in the pool as during land-based programs, and produces significantly less muscle damage (Robinson, Devor, Merrick, & Buckworth, 2004). The fact that similar increases in power resulted from both training program requires more detailed analyses beyond the scope of this paper; however, our results do indicate that overall the pool provides an effective environment for increasing muscular power in an older independently-living population.

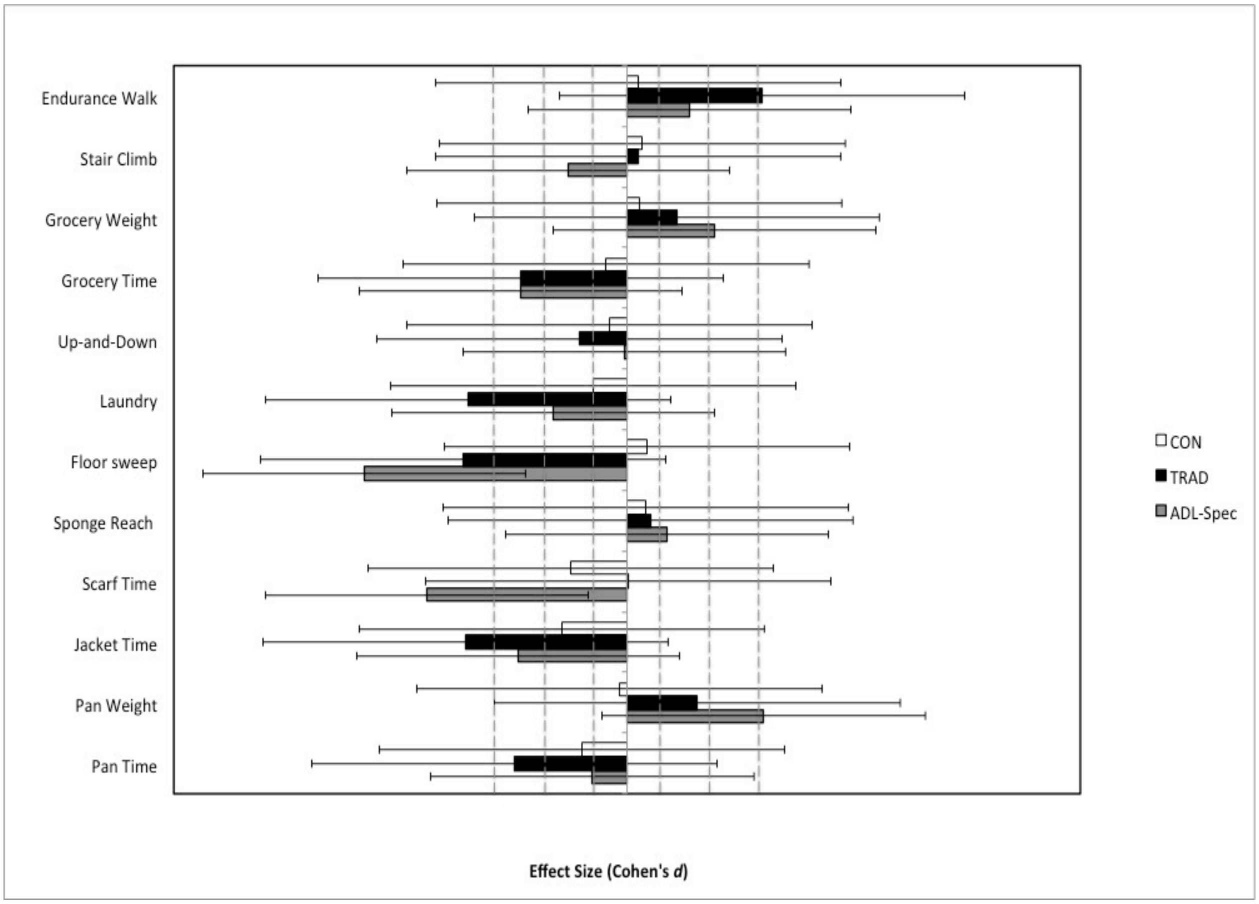
In examining improvements in physical measures and ADL functionality, the present investigation highlights responses to different aquatic training methods. While certain ADL tasks depend on sequential firing patterns and are best-addressed using programs based on biomechanical specificity; improvements in other less complex ADL tasks appear more dependent on physiological performance variables. In fact, certain tasks examined in this study, such as the 6-min walk and grocery task, tend to show greater improvements in response to more conventional exercise programs rather than a biomechanically specific exercise program. This highlights the potential to use these different training modalities in a periodized training program. The periodized program can employ traditional aquatic exercises during a preparatory or accumulation block, which concentrates on cardiovascular and/or neuromuscular fitness variables with long residual effects, while more biomechanically specific movement patterns can be used during the transmutation and realization blocks when improvements in fitness are "translated" into improvements in ADL-specific performance.

Of note are the differences between the ADL_{spec} and TRAD groups in the amount of time spent performing exercises during the one-hour training sessions. The novelty of every exercise performed in the ADL_{spec} group required that a portion of the overall one-hour class time be devoted to explaining the object of each exercise and its proper performance. Additionally, the interactive nature of the exercises performed by the ADL_{spec} group resulted in a visibly higher level of social engagement between the participants. The TRAD group did not have the same level of social engagement as the

ADL_{spec} group since each participant had only to concentrate on his or her own exercise performance. The similar responses in fitness variables and greater improvements in more complex ADL performance tests argue for the greater efficiency of the ADL_{spec} program.

One of the major limitations of this study was the small sample size used. In an effort to deal with this limitation a repeated-measures design was used to minimize the variability in the data. Another limitation was the lack of questionnaire assessments examining social constructs, such as self-efficacy, exercise social support, and exercise enjoyment. The high degree of social behavior exhibited by the ADL_{spec} exercise group is something that can be of great benefit, but due our failure to quantify these social interactions, these benefits could not be determined. It is suggested that future studies investigate the impact of traditional, biomechanically specific, and mixed exercise interventions and incorporate a larger sample size. It is also recommended that social variables such as enjoyment and social support be included along with physiological and ADL performance variables.

Figure 1. Effect sizes for pretest to post-test changes on the PFP-10.



Results displayed are Mean ± 95% CI SE.

Table 1. Anthropometric Data at Baseline

	ADL_{spec} (n = 9)	TRAD (n = 6)	CON (n = 6)
Body Weight (kg)	80.1 ± 14.3	80.5 ± 12.6	74 ± 13.1
Age (yrs)	68.7 ± 6.7	67.7 ± 9.6	66.3 ± 6
Height (m)	1.65 ± .07	1.74 ± .06 *	1.65 ± .08

ADL_{spec} = ADL-specific training group
TRAD = traditional aquatic training group
CON = controls
* Significantly different than ADL_{spec} and CON groups, $p < .029$.

Table 2. PFP-10 Data

	ADL_{spec}		TRAD		CON	
	(n = 9)		(n = 6)		(n = 6)	
Variable	Pre	Post	Pre	Post	Pre	Post
Pan Time (s)	2.7 ± .7	2.6 ± .6	2.9 ± .6	2.4 ± .6 *	2.5 ± .5	2.4 ± .5
Pan Weight (kg)	7.9 ± 2.5	9.9 ± 2.2 *	9.9 ± 2.5	11.2 ± 3.5	10.5 ± 2	10.3 ± 2.3
Jacket Time (s)	19.1 ± 5.2	15.4 ± 6 *	18.1 ± 4.2	14.4 ± 3.3 *	14 ± 3.1	12.6 ± 4.1
Scarf Time (s)	4.9 ± 1.3	3.5 ± 1 *	4.6 ± 1.2	4.6 ± 1.7	5.8 ± 2.4	4.8 ± 3.3
Sponge Reach (cm)	210.3 ± 8.4	212.2 ± 7.2	222 ± 8.3	223.3 ± 9.4	208.7 ± 9.8	209.8 ± 10.5
Floor Sweep (s)	24.2 ± 6.9	15.7 ± 3.1 *♯	32.6 ± 12.7	22.6 ± 6.6 *	28.9 ± 4.2	28 ± 4.8
Laundry (s)	36.4 ± 9.1	34 ± 7.5	38.4 ± 5.1	33.3 ± 5.3 *	33.8 ± 8.9	31.8 ± 7.7
Floor up and down (s)	14.4 ± 16.7	14.1 ± 15.1	17.1 ± 11.7	14.2 ± 8.6	9.7 ± 3.4	9.3 ± 4
Grocery Time (s)	53.3 ± 10.9	46.7 ± 9.5 *	59.9 ± 8.2	53.6 ± 11.3 *	56 ± 4.6	55.3 ± 6.9
Grocery Weight (kg)	9.5 ± 2	9.6 ± 3.9	11.9 ± 4	13.3 ± 5.6	12.1 ± 4.6	12.5 ± 5.5
Stair Climb (s)	7.2 ± 2.4	6.4 ± 1.8	7.4 ± 3.5	7.6 ± 3.2	6.6 ± 1.1	6.7 ± .8
6 min. Walk (m)	399.2 ± 123.1	450.8 ± 92.4 *	388.6 ± 77.5	459 ± 93.6*	495 ± 117.4	502.4 ± 102.9

ADL_{spec} = ADL-specific training group, TRAD = traditional aquatic training group, CON = controls. * Significantly better than Pre measure, $p < .046$. ♯Significantly better than TRAD and CON Groups, $p = .017$.

Table 3. Strength and Power Data

	ADL_{spec} (N = 9)		TRAD (N = 6)		CON (N = 6)	
Variable	Pre	Post	Pre	Post	Pre	Post
30s chair stand	11.1 ± 5	13.4 ± 6.3*	6.8 ± 6	9.3 ± 6.7*	13.2 ± 3.4	14 ± 4.7
30s arm curl	14.8 ± 4.6	17.5 ± 3.4*	12.5 ± 3	16.8 ± 2.4*	18 ± 3.1	21.8 ± 2.2
LB peak power (W)	621.7 ± 252	681.8 ± 257.2*	560.2 ± 158.5	616 ± 172*	626 ± 201.6	637.1 ± 209.5
LB avg. power (W)	501 ± 186	549.9 ± 206.2*	464.3 ± 118.8	500.3 ± 125.1*	495.1 ± 152.7	502.3 ± 156.6
LB peak power ($W \cdot kg^{-1}$)	7.7 ± 2.1	8.5 ± 2.2*	6.9 ± 1.5	7.6 ± 1.7*	8.3 ± 1.8	8.4 ± 2.1
LB avg. ($W \cdot kg^{-1}$)	6.2 ± 1.4	6.7 ± 1.5*	5.7 ± 1	6.2 ± 1.1*	6.5 ± 1.3	6.6 ± 1.4

ADL_{spec} = ADL-specific training group, TRAD = traditional aquatic training group, CON = controls.
*Significantly improved from pre to post measures, $p < .033$.

Table 4. ADL Specific Exercises	
Gallon jug lift to pool deck: sagittal plane.	The participant lifted a filled gallon jug from water level to the pool deck in the sagittal plane using both hands if necessary, progressing to one hand.
Gallon jug lift to pool deck, with side twist: frontal plane.	The participant stood with his/her right shoulder perpendicular to the pool deck. He or she then rotated at the waist as far from the pool deck as possible while holding a filled gallon jug. The participant then rotated toward the right shoulder and placed the gallon jug on the pool deck. This action was repeated on the other side.
Lat pushdown with empty gallon jug.	The participant held two empty gallon jugs under the water line in both hands. He or she started with the shoulders under the water line and only his or her head above water. The participant then resisted the buoyancy of empty jug as they used their latissimus dorsi to press the buoyant gallon down and resisted its buoyancy on the way back up to the starting position.
Figure 8's with empty gallon jug	With an empty gallon jug and starting with the water level at or slightly above his or her shoulders, the participant moved the jug in a figure 8 pattern, while turning at the waist and keeping the jug submerged at all times.
Empty gallon jug relay	Participants were placed in two groups and lined up with a 0ne-foot space between each participant. The gallon started along the front of the line and was passed submerged under water from person to person. Once the gallon reached the person on the end of the line, he or she jogged with the gallon to the beginning of the line and the pattern was repeated. After familiarization with the exercise the number of gallon jugs were increased.
Full gallon jug relay	Participants lined up in two groups, with a one-foot space between persons. The first person in line was standing next to the pool deck. On the pool deck a gallon jug full of water rested. At the word go the first person took the gallon jug down and it was passed down the line. The gallon jug remained overhead at all times. Once the jug reached the last person in line, he or she jogged to the front of the line and the pattern was repeated. Multiple jugs were added to increase the intensity of the exercise.

Strainer chest fly	Participants began with both arms extended in the frontal plane and a collapsible strainer in ether hand. To begin the exercise the participant adducted his or her arms brining them toward the midline of the body. The participant then brought the strainers back to the starting position. Participants were encouraged to move as fast as possible. At times they were asked to rotate the strainer so the open face of the strainer created maximal drag. Other times they were asked to rotate the strainer so the side was slicing through the water. An alternate exercise was to perform this on one foot to add a balance training component.
Strainer figure 8's	With a strainer in each hand and starting with the water level at or slightly above his or her shoulders, the participant moved each strainer in a figure 8 pattern, while turning at the waist and keeping the strainers submerged at all times. An alternate exercise was to perform this on one foot for balance training.
Strainer deltoid raise	Starting with a strainer in each hand, the participant began with his or her arms held at the sides. At the word go the participant raised his or her extended arms in the sagittal plane, while keeping the strainers under water at all times. An alternate exercise was to perform this on one foot to add a balance component.
Broom sweeping	The participant held the broom handle with one hand higher than the other, as one would while sweeping a floor. The participant was asked to imagine sweeping up dirt from the floor and to rotate at the waist moving as fast as possible. The exercise was repeated reversing grip positions.
Broom paddling	The participant held the broom handle with one hand higher than the other, as to simulate sweeping the floor. He or she is then brought the broom out of the water, reached forward, and then submerged the broom and pulled it back towards the body. The action was similar to paddling a canoe. The exercise was repeated with the hand positions reversed.
Broom circles	The participant held the broom handle with one hand higher than the other, as if sweeping the floor. The participant made a circular pattern with the broom, as if stirring a cauldron. The exercise was repeated with the hand positions reversed.

Laundry endurance walk	The participant walked and jogged through the water while holding a laundry basket. The basket provided resistance during the exercise.
Laundry push and pull	The participant started with the laundry basket held above the water line. While holding the handles on either end of the basket, he or she pushed the basket until it was completely submerged under the water line. The participant then brought the basket back up above the water line.
Laundry rotations	While holding the handles on either end of the laundry basket, the participant began the exercise standing with one foot next to the other. The participant was then instructed to take a step forward while rotating at the waist and turning the basket toward the side toward which he or she rotated. The participant returned to the start position with both feet together, and then stepped forward again with the opposite foot and rotated to the opposite side.
Stair stands	The participant sat on the steps leading into the pool. At the word go he or she stood up and then returned back to a seated position. The participant started in the deepest water possible and progressed to stairs closer to the water line. This increased the intensity of the exercise, as the participant now had to lift more of his or her body weight.
Stair stands with walk out	The participant performed a set number of stair stands and then walked out about 15 feet and returned for another set of stands. The participant alternated forward and backward walking, jogging, skipping, or side shuffling after each set of stair stand exercises.
Ankle weight pick up	The participant retrieved ankle weights from the pool floor. This was primarily done on the steps leading into the pool. This was the only exercise done with the participant's body mostly above the water line.
Colander transfer	Participants formed a circle and passed ankle weights and other objects to one another using a colander to pass the objects. The exercise focused on transfer tasks and grip strength.
Colander push, pull and rotation	The participant used a colander to push through the water in various directions including up, down, and side-to-side. The participant was asked to move as fast as possible through the water.
Jogging	Participants were asked to jog in the pool as part of their warm up and cool down segments of the workout. Jogging was also used as a recovery between intense ADL exercises.
Skipping	Participants were asked to skip or bound through the water with as much height or force as they felt comfortable.

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