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Changes in Physical Functioning in the Active Living Every Day Program of the Active for Life Initiative®

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Abstract
Background Physical activity can prevent or delay the onset of physical functional limitations in older adults. There are limited data that evidence-based physical activity interventions can be successfully translated into community programs and result in similar benefits for physical functioning.
Purpose The purpose of this study is to measure the effects of the Active Living Every Day program on physical functioning and physical functional limitations in a diverse sample of older adults.
Methods As a part of the Active for Life initiative, the Council on Aging of Southwestern Ohio implemented Active Living Every Day (ALED), a group-based lifestyle behavior change program designed to increase physical activity. Performance-based physical functioning tests (30-s Chair Stand Test, eight Foot Up-and-Go Test, Chair Sit-and-Reach Test, 30-Foot Walk Test) were administered to participants at baseline and posttest. Baseline to post-program changes in physical functioning and impairment status were examined with repeated measures analysis of covariance. Interactions tested whether change over time differed according to race/ethnicity, body mass index (BMI), and baseline impairment status.
Results Participants significantly increased their performance in all four physical functioning tests. The percentage of participants classified as "impaired" according to normative data significantly decreased over time. Physical functioning improved regardless of BMI, race/ethnicity, or baseline impairment status.
Conclusions ALED is an example of an evidenced-based physical activity program that can be successfully translated into community programs and result in significant and clinically meaningful improvements in performance-based measures of physical functioning.

Keywords Physical activity · Exercise · Translational research · Behavioral intervention

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Introduction

As adults age, limitations in functional abilities increase, often resulting in impairments in tasks of everyday living.

Preventing functional limitations can help individuals maintain their quality of life and reduce their medical care expenditures [1]. Physical activity has been shown to prevent or delay the onset of physical functional limitations in older adults [2–4]. Unfortunately, both self-report and objective data indicate that older adults are not engaging in the recommended amounts of physical activity necessary for health benefits [5, 6].

A number of studies have shown that exercise interventions can improve physical functioning [2, 3, 7–17]. Studies in this area have typically been multicomponent (i.e., aerobic, strength, balance, and flexibility) [2, 3, 9–15], have been conducted in a supervised, center-based setting [3, 9, 12–17], and included exercise goals of three to five times per week, for 20-60 min [3, 9, 11, 12, 14, 16, 17]. There is a need to examine whether these benefits can occur through less structured, community-based programs.

Physical activity as a means of improving or maintaining physical functioning is promising; however, a number of gaps in the extant literature exist. It is unclear if and how these evidence-based physical activity interventions in older adults can be successfully translated into community programs and if they result in similar benefits. In order for such programs to make a public health impact, evidence-based programs need to be successfully translated into community settings. Second, the effect of physical activity on functional limitations most likely varies depending on baseline functioning. In older adults with substantial existing functional limitations, physical activity probably provides a therapeutic or rehabilitative effect, whereas in older adults without substantial functional limitations, the effect of physical activity is presumably to prevent worsening of existing functional ability. Studies typically do not stratify results by baseline functional ability [2, 9–11, 13, 14, 17], and thus it is often difficult to discern the severity of functional limitations in the participants from the published results [18]. Third, because the prescribed dose of physical activity does not vary much across studies, it is difficult to determine whether a dose response exists, or how much physical activity is necessary to improve or maintain functional ability [18]. Finally, there is concern that randomized controlled trials recruit non-representative samples of community adults. Although some studies include diverse populations [3, 8, 11, 12, 15], few report differences across racial/ethnic groups [3, 8, 15]. We need more information on the effects of physical activity in less advantaged and more ethnically diverse subgroups [3, 18].

Active for Life (AFL) was a 4-year translational initiative that successfully implemented two evidence-based behavior modification programs (Active Choices [AC] and Active Living Every Day [ALED]) into "real-world" community settings with diverse populations, resulting in significant improvements in self-reported physical activity in midlife and older adults [19]. One AFL site, Council on Aging of Southwestern Ohio, conducted baseline and post-program performance-based physical functioning tests with participants taking part in the ALED program. The purpose of this study was to examine whether ALED was associated with improvements in physical functioning and reductions in physical functional limitations in a diverse sample of older adults. Furthermore, we examined whether changes in physical functioning differed according to selected baseline characteristics, and if there was a dose response relationship between physical activity and physical functioning.

Methods

Participants

Participants were recruited from various locations including senior centers, YMCAs, community recreation centers, retirement communities, and churches. The most successful recruitment efforts were on-site staff recruitment, presentations at the facilities, direct mail, flyers, newsletters, and local media. Participants were screened by the site staff for eligibility. The site contracted with the program facilitators and provided the expertise to oversee the program development, implementation, and ongoing sustainability.

Participants were ≥50 years of age, sedentary or underactive (≤2 days/week and <120 min/week), and free of medical conditions or disabilities that required higher levels of supervision, as determined by lead staff [19]. Although medical clearance to participate in the testing and intervention was not required, participants who endorsed any Physical Activity Readiness Questionnaire item were excluded from the 30-s Chair Stand Test (n=186) and those who endorsed the Physical Activity Readiness Questionnaire item about dizziness were excluded from the Eight Foot Up-and-Go Test (n=12). All participants completed an informed consent form approved by the Institutional Review Boards at the University of South Carolina, Texas A & M Health Science Center, and the legal counsel of the Council on Aging of Southwestern Ohio.

Research Design and Procedure

This study used a pre-post design, with data collected from 2003 to 2007. Participants were recruited over a 4-year period of time. Participants completed a survey assessing sociodemographic characteristics, physical activity, other health-related practices, and psychosocial variables, and four performance-based physical functioning tests at baseline and at 20 weeks. Approximately 100 participants in each year completed full surveys. This decision was made a priori as it was not necessary for adequate statistical power to collect survey data on all participants across all years. Thus, the sample sizes are smaller for the analyses on the physical functioning and self-reported physical activity measures, due to missing physical activity data.

Program Overview

Details of AFL are described elsewhere [19, 20]. In brief, AFL was a translational initiative that evaluated the effects of two evidence-based physical activity interventions, ALED and AC, on self-reported physical activity and related outcomes in midlife and older adults. AC was a 6-month telephone-based program [21–23], whereas ALED was a 20-week group-based program (more details of ALED are described below) [24, 25]. Results showed significant increases in moderate-to-vigorous intensity physical activity (MVPA) and total physical activity. Results were generally consistent across years and sites [19]. Only participants recruited from the Council on Aging of Southwestern Ohio/Hamilton County Health Department, who implemented ALED, are reported in this paper, as this was the only site that conducted physical functioning measures.

Intervention

ALED, as originally developed, is a 20-week lifestyle physical activity intervention that teaches the cognitive and behavioral skills necessary to become and remain physically active. Each week, participants attended a 60-min group-based session that focused on cognitive and behavioral strategies consistent with the Social Cognitive Theory [26] and the Transtheoretical Model [27]. Participants received a book that covered weekly class materials (e.g., goal setting, problem-solving, self-monitoring) and contained worksheets and assignments. The goal of ALED was to help participants accumulate at least 30 min of MVPA on most days of the week.

After year 3, the lead organizations taking part in AFL requested that the ALED program be shortened to 12 weeks. Although the program was shortened in year 4, steps were taken to ensure essential elements were maintained (e.g., extending class length and removing redundant information) [19]. Participants taking part in the intervention during year 4 completed the physical functioning tests at 12 weeks and a post-program follow-up survey at 20 weeks.

Measures

Lead staff was trained by an expert in physical functioning in how to administer the performance-based measures. The training was interactive and included didactic and hands-on assessments. These lead staff trained and oversaw staff onsite to conduct the measurements. The test manual and videotape provided by Human Kinetics, Inc. were used to aid trainings [28].

Socio-demographic and Health-Related Variables Participants reported their date of birth, gender, race/ethnicity, and presence of chronic health conditions. Height to the nearest 0.5 in. and weight to the nearest 0.1 pound were obtained by trained staff. Body mass index (BMI) was calculated using the standard equation in SI units.

Physical Activity The 41-item Community Health Activities Model Program for Seniors (CHAMPS) questionnaire was used to assess physical activity [29]. This self-report measure assesses the frequency and duration of various activities typically undertaken by older adults for exercise, activities undertaken in the course of their day that are physical in nature, and recreational activities that provide physical activity. The frequency of the activity is assessed as the number of times per week, and the duration is assessed as total time per week using a six-item scale ranging from “less than 1 hour a week” to “9 or more hours per week.” Minutes/week spent in MVPA (MET value of $\geq$3.0) was calculated. This measure is valid [30], has acceptable test-retest reliability [30], and is sensitive to change [22, 29, 31–33]. In year 2 of the study, only those 21 items used to score the CHAMPS were administered in order to reduce participant burden.

Physical Functioning Four performance-based measures were used to assess physical functioning: the 30-s Chair Stand Test, the Eight Foot Up-and-Go Test, the Chair Sit-and-Reach Test, and the 30-Foot Walk Test. These tests, which we expected would be sensitive to change as a result of the intervention, did not require much time to administer, and could be administered in most of the settings (i.e., did not require special space). Each of these tests was administered during all 4 years of AFL with the exception of the Chair Sit-and-Reach Test, which was only administered during year 3.

30-s Chair Stand Test The 30-s Chair Stand Test assessed lower body strength [28]. Participants sat in the middle of a 17-in. (37.4 cm) high chair with their back straight, feet flat on the floor, with their arms crossed at the wrist and held against the chest. On the signal, “go” participants rose to a full stand and returned to a fully seated position, without pushing off with the arms. Participants completed as many stands as possible. The test score was the total number of stands completed in 30 s.

Eight Foot Up-and-Go Test The Eight Foot Up-and-Go Test assessed agility and dynamic balance [28]. Participants sat in the middle of a 17-in. high chair with their back straight, feet flat on the floor, and their hands on the thighs. On the signal "go" participants got up from the chair, walked as quickly as possible around a cone placed 8 ft (2.4 m) from the chair, and sat back down. Participants completed one practice test and two test trials. The test score was the faster of the two trials, recorded to the nearest 1/10 of a second by a standard stopwatch.

Chair Sit-and-Reach Test The Chair Sit-and-Reach Test assessed lower-body (primarily hamstring) flexibility [28]. Participants sat on the front edge of a 17-in. high chair and extended one leg out as straight as possible in front of the hip, with the foot flexed and heel resting on the floor. With their arms outstretched, hands overlapping, and middle fingers even, participants slowly bent forward at the hip joint, reaching as far forward as possible toward (or past) the toes. Participants had to hold their maximum reach for 2 s. The distance from the tips of the middle fingers to the top of the shoe (to the nearest 0.5 in) was measured. The "zero point" was considered the midpoint at the top of the shoe. A reach short of this point was recorded as a minus (−) score; a reach touching this point was recorded as a zero; and a reach past this point was recorded as a plus (+) score. Participants completed two practice trials and two test trials. The test score was the best (highest) of the two trials.

30-Foot Walk Test The 30-Foot Walk Test assessed walking speed [34]. The test was performed twice; first at the participants' preferred walking speed, and then at their fastest walking speed. On the signal "ready, go", participants started walking. The stopwatch did not start until the participant crossed the 10-ft (3.0 m) line, and was subsequently stopped when the participant crossed the 40-ft (12.2 m) line. The test score was the time to the nearest 1/10 of a second. The fastest walking speed trial was used in analyses.

Statistical Analyses

Participants who completed any baseline physical functioning test and had complete model covariates (gender, age, race/ethnicity, and BMI) were included in the baseline demographic analyses. Differences among participants who completed baseline tests only versus those who completed both baseline and post-program assessments were examined with χ^2 or t tests. Square root transformations were conducted on both baseline and post-program scores for MVPA, the Eight Foot Up-and-Go Test, and the 30-Foot Walk Test, as these measures were skewed and/or had high kurtosis. The transformations successfully corrected the problem(s).

Two types of change analyses were conducted. The first used all available data from participants. Because of the missing post-program data on a considerable number of participants, the second type of change analyses used an intent-to-treat model, which assumed no change in outcomes among participants who did not complete post-program measures by carrying forward baseline values. This more conservative approach was compared to results from analyses with all available data. Unless results were significantly different, we report the findings based on the first approach.

Changes in Physical Functioning

A repeated measures analysis of covariance (ANCOVA; using a mixed model analysis) examined baseline to post-program changes in physical functioning. Each of the four performance-based measures was tested in a separate model, and all models controlled for gender, age, race/ethnicity, and BMI. Participants with modifications that were the same at both time points, e.g., participants who used the same assistive device at baseline and post-program assessments for the Eight Foot Up-and-Go Test (all but six participants) and the 30-Foot Walk test (all but nine participants), were included in change analyses. Participants with modifications that were not the same at both time points were included in the carry forward analyses by carrying forward their baseline test value. For the Chair Sit-and-Reach Test, if the outstretched leg differed from baseline to post-program assessments (n=52), the participant's data were only used in carry forward analyses by carrying forward the baseline test value. Effect sizes (d= post-program mean−baseline mean/baseline standard deviation) using adjusted means were computed for each of the four physical functioning measures [35]. Using Cohen's effect sizes [36], d=0.2 was considered small, d=0.5 medium, and d=0.8 large.

Changes in Impairment Status

Based on Rikli and Jones' [28] normative data, participants' 30-Second Chair Stand, Eight Foot Up-and-Go, and Chair Sit-and-Reach test scores were classified as impaired (≤ 25th percentile) or within normal limits (>25th percentile) at baseline and post-program (normative data are not available for the 30-Foot Walk Test so this test was not used for these analyses). Because norms have only been developed for persons aged 60-94 years, we applied the 60-64 years of age norms to any participant<60 years, and the 90-94 years of age norms to participants>94 years. Participants who modified test procedures at baseline (e.g., used a cane or walker, n=20 for the Eight Foot Up and Go) were not included in any impairment status analyses. Participants with modifications at post-program only (not at baseline) were included in the carry forward analyses by carrying forward their baseline impairment status.

A repeated measures ANCOVA (using a mixed model analysis) examined whether the percentage classified as impaired (dichotomized variable) changed from baseline to post-program. Each of the performance-base measures was tested in a separate model, controlling for the same variables listed above.

Dose-Response Relationship—MVPA and Physical Functioning

Residualized change scores were computed for both MVPA and each of the four physical functioning measures. Linear regression was used to examine the relationship between change in physical activity and change in each of the four physical functioning measures, after controlling for the same covariates listed above.

Changes in Physical Functioning by Baseline Variables

A repeated measures ANCOVA (using a mixed model analysis) was conducted to examine whether changes in physical functioning from baseline to post-program differed according to race/ethnicity (White vs. Non-white), BMI (normal weight, overweight, obese), and baseline impairment status (impaired vs. not impaired). Time×baseline predictor interactions were tested for each of the four physical functioning measures, after controlling for the same covariates listed above.

Results

This study included 877 participants who completed at least one baseline performance-based physical functioning test. Of the total sample, 83% were white and 16% were African American, 85% were female, 85% were overweight or obese, 43% were married or partnered, 56% had at least some college education, and 67% self-reported at least two chronic health conditions. The mean age was 71.2±9.1 years, and the mean BMI was 31.5±7.0 kg/m^2. Participants engaged in 2.7±4.0 h/week of MVPA at baseline. Table 1 shows the adjusted baseline scores for each of the four physical functioning tests, whereas Table 2 shows the percentage (adjusted) of participants impaired according to Rikli and Jones' [28] normative data. Participants attended 68.5% of the ALED sessions during the intervention period.

Participants who completed baseline and post-program assessments performed significantly better on the baseline 30-s Chair Stand Test, the Eight Foot Up-and-Go Test, and the 30-Foot Walk Test compared to those who completed baseline assessments only. There were no significant differences in demographic variables or baseline physical activity among these two groups.

Changes in Physical Functioning

Participants experienced significant baseline to post-program improvements in all four performance-based physical functioning tests. Table 1 shows the adjusted baseline and post-program mean scores for all tests, as well as the calculated effect sizes for the change. The magnitude of the effects was small ranging from −0.17 to 0.37.

Changes in Impairment Status

The percentage of participants classified as "impaired" significantly decreased over time for all three physical functioning measures. Table 2 shows the percentage impaired at baseline and post-program for the physical functioning tests.

Associations between Changes in MVPA and Changes in Functional Fitness

Increases in MVPA were related to significant improvements in the Eight Foot Up-and-Go Test ($r=-0.27$, $p=0.03$), suggesting a dose-response relationship. This significant association remained after controlling for race/ethnicity, age, BMI, and gender ($p=0.006$). The same relationship was found for the 30-s Chair Stand Test ($r=0.18$, $p=0.03$), however, the relationship was not statistically significant after controlling for covariates ($p=0.32$). Changes in MVPA were not significantly associated with changes in the Chair Sit-and-Reach Test ($r=-0.11$, $p=0.48$) or the 30-Foot Walk Test ($r=-0.11$, $p=0.13$).

Associations between Baseline Variables and Changes in Functional Fitness

Table 3 shows whether changes in physical functioning over time differed by race/ethnicity, BMI, and baseline impairment status. Race/ethnicity and BMI category were unrelated to improvements in any of the four physical functioning measures, indicating that improvements were similar across race and weight status groups.

Baseline impairment status was significantly related to post-program changes in the Eight Foot Up-and-Go Test ($p<0.0001$) and the 30-s Chair Stand Test ($p<0.0001$). Although all participants had significant improvements in both tests, participants who were classified as impaired at baseline showed significantly greater post-program improvements in both tests compared to those who were not impaired at baseline.

Table 1 Baseline and post-program means (SE) in performance-based physical functioning measures and self-reported physical activity

	Baseline Mean (SE)	Post-program Mean (SE)	*F* statistic, *p* value	Effect size (d)
30-sec Chair Stands, #	10.7 (0.22)	12.1 (0.24)	81.62, <0.0001	0.37
Eight Foot Up & Go, seconds	6.8 (0.12)	6.4 (0.12)	77.82, <0.0001	−0.23
Chair Sit-and-Reach, inches	−1.6 (0.57)	−0.5 (0.57)	9.02, 0.0030	0.32
30-Foot Walk Test, seconds	6.1 (0.10)	5.8 (0.10)	40.88,<0.0001	−0.17
Physical Activity, hours/week of MVPA	3.5 (0.35)	5.6 (0.38)	88.50, ≤0.0001	0.55

Means and standard errors are adjusted for race/ethnicity (White vs. Non-white), age, BMI, and gender. Effect sizes (d) are computed using adjusted baseline and post-program means and baseline unadjusted standard deviations. For the Eight Foot Up & Go and 30 Foot Walk Test, a negative effect size indicates a more favorable change. Square root transformations were conducted for Eight Foot Up & Go, 30-Foot Walk Test, and PA, and were used in all change analyses and effect size calculations. Because the untransformed means and standard deviations are more meaningful, they are presented in this table. Means and standard errors are presented for those who completed the measure at both time periods (change analyses). For the 30-s Chair Stand, 354 participants were used in change analyses and 656 were used in carry forward analyses. For the Eight Foot Up & Go, 546 participants were used in change analyses and 834 were used in carry forward analyses. For the Chair Sit-and-Reach, 98 participants were used in change analyses and 267 were used in carry forward analyses. For the 30-Foot Walk, 485 participants were used in change analyses and 865 were used in carry forward analyses. For physical activity, 263 participants were used in change analyses and 376 were used in carry forward analyses

Discussion

The major finding of this study is that ALED significantly improved physical functioning and reduced the percentage of participants classified as "impaired" according to fitness norms [28] in a sample of older adults with diverse levels of baseline physical functioning statuses. Effect sizes were in the small to medium range; applied to the entire population, these changes in functional ability would be very meaningful. ALED, a behavioral intervention, resulted in significant increases in physical activity. Although strength and flexibility exercises were encouraged during the group-based sessions, the main focus of ALED was increasing aerobic activity to 30 min of MVPA on most days. Therefore, it is likely that the changes seen in physical activity were via aerobic activity. Effect sizes may have been larger had strength, flexibility, and balance activities been specifically targeted, as a number of exercise modes may contribute to improvements in functional fitness [10].

A major gap in the existing literature is whether physical activity programs can effectively improve physical functioning across racial/ethnic and weight status groups [18]. We found significant improvements irrespective of race and BMI. Our findings are consistent with the results from the

Table 2 Baseline and post-program impairments (%) in physical functioning impairment status

	Baseline %	Post-program %	*F* statistic, *p* value
30-sec Chair Stands			
Impaired, %	60.86	41.38	103.78, <0.0001
Not Impaired, %	39.14	58.65	
Eight Foot Up & Go			
Impaired, %	50.16	39.56	71.75, <0.0001
Not Impaired, %	49.84	60.44	
Chair Sit-and-Reach			
Impaired, %	42.64	28.97	10.19, 0.0019
Not Impaired, %	57.36	71.06	

Percentages are adjusted for race/ethnicity (white vs. non-white), age, BMI, and gender. Because there are not established norms for the 30-Foot Walk Test, analyses were not preformed on this physical functioning measure

Percentages are presented for those who completed the measure at both time periods (change analyses). For the 30-s Chair Stand, 354 participants were used in change analyses and 656 were used in carry forward analyses. For the eight Foot Up & Go, 447 participants were used in change analyses and 789 were used in carry forward analyses. For the Chair Sit-and-Reach, 98 participants were used in change analyses and 267 were used in carry forward analyses

Table 3 Baseline and post-program means (SE) in physical functioning, by baseline variables

	Baseline *n*, Mean (SE)	Post-Program *n*, Mean (SE)	*F* statistic, *p* value	Effect size (d)
30-sec Chair Stands, #				
Time×race/ethnicity				
White	11.0 (0.20)	12.3 (0.24)	0.03, 0.8668	0.37
Non-white	10.5 (0.37)	11.8 (0.42)		0.37
Time×BMI				
Normal	11.6 (0.33)	13.3 (0.40)	0.76, 0.4702	0.49
Overweight	11.4 (0.23)	12.6 (0.28)		0.36
Obese	10.8 (0.20)	12.3 (0.23)		0.41
Time×baseline				
Impairment status				
Impaired	8.8 (0.19)	10.9 (0.23)	18.94, <0.0001	0.65
Not impaired	13.8 (0.22)	14.6 (0.25)		0.37
Eight Foot Up & Go, seconds				
Time×race/ethnicity				
White	6.7 (0.11)	6.3 (0.11)	0.00, 0.9607	−0.23
Non-white	6.9 (0.20)	6.5 (0.20)		−0.25
Time×BMI				
Normal	5.9 (0.23)	5.6 (0.14)	0.23, 0.7959	−0.21
Overweight	6.5 (0.17)	6.1 (0.17)		−0.20
Obese	7.3 (0.14)	6.8 (0.14)		−0.24
Time×baseline				
Impairment status				
Impaired	8.3 (0.11)	7.5 (0.12)	60.83, <0.0001	−0.42
Not impaired	5.8 (0.11)	5.7 (0.11)		−0.09
Chair Sit-and-Reach, inches				
Time×race/ethnicity				
White	−1.9 (0.53)	−0.6 (0.54)	1.22, 0.2710	0.35
Non-white	−0.9 (0.99)	−0.8 (0.99)		0.06
Time×BMI				
Normal	−2. 7 (1.54)	1.5 (1.54)	1.85, 0.1610	0.93
Overweight	−1.4 (0.89)	−0.5 (0.90)		0.34
Obese	−1.1 (0.78)	−0.0 (0.79)		0.29
Time×baseline				
Impairment status				
Impaired	−1.9 (0.73)	−0.6 (0.75)	0.00, 0.9532	0.51
Not impaired	−0.6 (0.91)	0.7 (0.91)		0.64
30-Foot Walk Test, seconds				
Time×race/ethnicity				
White	6.2 (0.08)	5.9 (0.08)	0.39, 0.5329	−0.16
Non-white	6.0 (0.16)	5.8 (0.16)		−0.14
Time×BMI				
Normal	5.3 (0.16)	5.2 (0.16)	0.15, 0.8650	−0.16
Overweight	5.7 (0.11)	5.5 (0.11)		−0.17
Obese	6.0 (0.10)	5.7 (0.10)		−0.15

Means, standard errors, and repeated measures analyses examining change over time (time×baseline variable) are adjusted for race/ethnicity (White vs. Non-white), age, BMI, and gender. Square root transformations were conducted for Eight Foot Up & Go and 30-Foot Walk Test, and were used in all change analyses and effect size calculations. Because the untransformed means and standard deviations are more meaningful, they are presented in Table 4. Because there are not established norms for the 30-Foot Walk Test, the time x baseline impairment status analyses were not performed on this physical functioning measure. Effect sizes (d) are computed using adjusted baseline and post-program means and baseline unadjusted standard deviations. For the Eight Foot Up & Go and 30-Foot Walk Test, a negative effect size indicates a more favorable change

LIFE-P study [3], the EnhanceFitness program [15], and the Fitness Arthritis and Seniors Trial (FAST) [8], which found improvements in physical functioning across all race/ethnic groups. We found only one community-based study that examined intervention effects across BMI categories, and similar to our findings, the FAST intervention found improvements in physical functioning across BMI categories [8].

Although all participants showed significant improvements in the 30-s Chair Stand Test and the Eight Foot Up-and-Go Test, those who were impaired at baseline improved significantly more than those not impaired. Those impaired likely had more room for improvement relative to those who were not (i.e., ceiling effect), resulting in larger effect sizes. Our results are similar to those of the LIFE-P study which found significant improvements in physical functioning regardless of participant's baseline physical performance scores [3]. Similarly in the EnhanceFitness program, Belza et al. [15] found significant improvements at 4 and 8 months in the 30-s Chair Stand and Arm Curl Tests for participants who were both below or within Rikli and Jones' age and gender normative data [28]. Although there were significant improvements in the Eight Foot Up-and-Go Test at both time points for those below normal limits at baseline, those who were within this threshold significantly worsened their score at 4 months and had no change at 8 months [15].

We found significant dose response relationships for the Eight Foot Up-and-Go Test and the 30-s Chair Test (although not after controlling for covariates), where increases in physical activity were associated with significant improvements in physical functioning. The lack of significant findings for the Sit-and-Reach test may have been due to the much smaller sample size (n=41). Although the sample size for the 30-Foot Walk Test was larger, this test had a smaller effect size (in change analyses), which could also speak to reduced power to detect a small change over time. Furthermore, as mentioned above, the primary target of ALED was aerobic activity. Strength, flexibility, and balance activities may be more important for changing particular functional tests (e.g., sit and reach).

The appropriateness of ALED for those who are already experiencing declines in physical functioning, and likely have the most to gain from such physical activity-based programs, is especially encouraging. Low levels of physical functioning have been associated with subsequent disability, mortality, mobility limitations, falls, hospitalization, requirement of a caregiver, and nursing home admissions [37–40]. Our findings have clinical significance, as community-based prevention programs that focus on increasing physical activity (e.g., ALED), may be able to reverse physical functional impairments, and reduce the risk for these adverse events associated with low levels of physical functioning. Furthermore, given the potential large reach, ALED can result in significant improvements in an important public health problem.

This study had a number of strengths including the use of objective measures to assess multiple components of physical functioning and the large sample size. Very few studies have been able to examine intervention effects according to participant characteristics with such high power. The findings from this study corroborate the overall positive results of the AFL initiative [19].

We also recognize study limitations. First, and perhaps the biggest limitation to our study, is the lack of a control group, which can threaten internal validity. While this limitation is important, we believe that our focus on external validity ads to the overall physical activity and health science base. The goal of AFL was not to test the efficacy of the ALED program, but instead to impact communities by translating the program broadly. Second is the difference among those who did and did not complete posttest assessments. However, results from our carry forward analyses found that even if participants who had no post-program measurement showed no change at post-test, significantly meaningful improvements would still exist. Third, over half of participants had at least some college education. These people may be more likely to succeed in a self-directed intervention that involves attending group-based classes and completing worksheets, limiting generalizability. However, earlier reports from AFL show that changes in physical activity were seen across sites, with some sites recruiting more disadvantaged participants [41]. Finally, only one of the 12 AFL sites administered physical functioning tests. It is not certain whether results would be the same across other study sites or if AC would have yielded similar findings.

Conclusions

Our findings address some of the gaps in the existing literature [18], and particularly address the need for translational research on physical functioning and functional limitations in diverse samples of older adults. ALED is an example of an evidenced-based physical activity program that can be successfully translated into community programs and result in significant improvements in physical functioning, similar to those achieved in efficacy studies. Significant improvements in all performance-based physical functioning tests were seen in participants regardless of BMI, race/ethnicity, and baseline impairment status, which points to the appropriateness of ALED across diverse older adult populations. The significant improvement among those with existing limitations is particularly meaningful, and supports late-life physical activity as a means to reverse the potentially debilitating effects, both physically and mentally, of functional impairments.

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References

1. Centers for Disease Control and Prevention. Healthy aging—improving and extending quality of life among older Americans: at a glance. 2009. [http://www.cdc.gov/NCCdphp/publications/aag/pdf/healthy_aging.pdf]. Atlanta, GA: Centers for Disease Control and Prevention.
2. Nelson ME, Layne JE, Bernstein MJ, Nuernberger A, Castaneda C, Kaliton D, et al. The effects of multidimensional home-based exercise on functional performance in elderly people. J Gerontol A Biol Sci Med Sci. 2004;59:154–60.
3. LIFE Study Investigators. Effects of a physical activity intervention on measures of physical performance: results of the Lifestyle Interventions and Independence for Elders Pilot (LIFE-P). J Gerontol A Biol Sci Med Sci. 2006;61:1157–65.
4. Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. 2007;39:1435–45.
5. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008;40:181–8.
6. Centers for Disease Control and Prevention. Behavioral risk factor surveillance system survey data. Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2007.
7. Rejeski WJ, Marsh AP, Chmelo E, Prescott AJ, Dobrosielski M, Walkup MP, et al. The Lifestyle Interventions and Independence for Elders Pilot (LIFE-P): 2-year follow-up. J Gerontol A Biol Sci Med Sci. 2009;64:462–7.
8. Ettinger WH, Jr., Burns R, Messier SP, Applegate W, Rejeski WJ, Morgan T, Shumaker S, Berry MJ, O'Toole M, et al. A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis. The Fitness Arthritis and Seniors Trial (FAST). JAMA. 1997; 277:25-31.
9. Toraman NF, Erman A, Agyar E. Effects of multicomponent training on functional fitness in older adults. J Aging Phys Act. 2004;12:538–53.
10. Takeshima N, Rogers NL, Rogers ME, Islam MM, Koizumi D, Lee S. Functional fitness gain varies in older adults depending on exercise mode. Med Sci Sports Exerc. 2007;39:2036–43.
11. Morey MC, Peterson MJ, Pieper CF, Sloane R, Crowley GM, Cowper PA, et al. The Veterans Learning to Improve Fitness and Function in Elders Study: a randomized trial of primary care-based physical activity counseling for older men. J Am Geriatr Soc. 2009;57:1166–74.
12. Fitzpatrick SE, Reddy S, Lommel TS, Fischer JG, Speer EM, Stephens H, et al. Physical activity and physical function improved following a community-based intervention in older adults in Georgia senior centers. J Nutr Elder. 2008;27:135–54.
13. Yamauchi T, Islam, M.M., Koizumi, D., Rogers, M.E., Rogers, N.L., & Takeshima, N. Effect of home-based well-rounded exercise in community-dwelling older adults. J Sports Sci & Med. 2005;4:563-71.
14. Cress ME, Buchner DM, Questad KA, Esselman PC, deLateur BJ, Schwartz RS. Exercise: effects on physical functional performance in independent older adults. J Gerontol A Biol Sci Med Sci. 1999;54:M242–8.
15. Belza B, Shumway-Cook A, Phelan EA, Snyder S, LoGrefo JP. The effects of a community-based exercise program on function and health in older adults: The EnhanceFitness Program. J Appl Gerontol. 2006;25:291–306.
16. Kalapotharakos VI, Michalopoulos M, Strimpakos N, Diamantopoulos K, Tokmakidis SP. Functional and neuromotor performance in older adults: effect of 12 weeks of aerobic exercise. Am J Phys Med Rehabil. 2006;85:61–7.
17. Simons R, Andel R. The effects of resistance training and walking on functional fitness in advanced old age. J Aging Health. 2006;18:91–105.
18. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee report. Washington, D. C.: US Department of Health and Human Services; 2008.
19. Wilcox S, Dowda M, Leviton LC, Bartlett-Prescott J, Bazzarre T, Campbell-Voytal K, et al. Active for life final results from the translation of two physical activity programs. Am J Prev Med. 2008;35:340–51.
20. Wilcox S, Dowda M, Griffin SF, Rheaume C, Ory MG, Leviton L, et al. Results of the first year of active for life: translation of 2 evidence-based physical activity programs for older adults into community settings. Am J Public Health. 2006;96:1201–9.
21. King AC, Baumann K, O'Sullivan P, Wilcox S, Castro C. Effects of moderate-intensity exercise on physiological, behavioral, and emotional responses to family caregiving: a randomized controlled trial. J Gerontol A Biol Sci Med Sci. 2002;57:M26–36.
22. King AC, Pruitt LA, Phillips W, Oka R, Rodenburg A, Haskell WL. Comparative effects of two physical activity programs on measured and perceived physical functioning and other health-related quality of life outcomes in older adults. J Gerontol A Biol Sci Med Sci. 2000;55:M74–83.
23. King AC, Haskell WL, Young DR, Oka RK, Stefanick ML. Long-term effects of varying intensities and formats of physical activity on participation rates, fitness, and lipoproteins in men and women aged 50 to 65 years. Circulation. 1995;91:2596–604.
24. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW, 3rd, Blair SN. Reduction in cardiovascular disease risk factors: 6-month results from Project Active. Prev Med. 1997 Nov-Dec;26:883-92.
25. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW, Blair SN. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial. JAMA. 1999;281:327–34.
26. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs: Prentice-Hall; 1986.

27. Prochaska JO, DiClemente CC, Norcross JC. In search of how people change. Applications to addictive behaviors. Am Psychol. 1992;47:1102–14.
28. Rikli REJ, C.J.,. Senior fitness test manual. Champaign: Human Kinetics; 2001.
29. Stewart AL, Mills KM, King AC, Haskell WL, Gillis D, Ritter PL. CHAMPS physical activity questionnaire for older adults: outcomes for interventions. Med Sci Sports Exerc. 2001;33:1126–41.
30. Harada ND, Chiu V, King AC, Stewart AL. An evaluation of three self-report physical activity instruments for older adults. Med Sci Sports Exerc. 2001;33:962–70.
31. Stewart AL, Mills KM, Sepsis PG, King AC, McLellan BY, Roitz K, Ritter PL. Evaluation of CHAMPS, a physical activity promotion program for older adults. Ann Behav Med. 1997 Fall;19:353-61.
32. Stewart AL, Verboncoeur CJ, McLellan BY, Gillis DE, Rush S, Mills KM, et al. Physical activity outcomes of CHAMPS II: a physical activity promotion program for older adults. J Gerontol A Biol Sci Med Sci. 2001;56:M465–70.
33. Stewart AL. Community-based physical activity programs for adults age 50 and older. J Aging Phys Act. 2001;9:S71–91.
34. Theou O, French J, Hernandez D, Rose DJ, Jones J. Measuring older adult gait speed in community settings using the 30 foot-walk at preferred and maximum speed. Med Sci Sports Exerc. 2006;38:S331.
35. Wolf FM. Quantitative methods for research synthesis. Newbury Park, CA: Sage; 1986.
36. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. ed. Hillsdale, NJ: Lawrence Erlbaum; 1988.
37. Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. N Engl J Med. 1995;332:556–61.
38. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol A Biol Sci Med Sci. 1994;49:M85–94.
39. Onder G, Penninx BW, Ferrucci L, Fried LP, Guralnik JM, Pahor M. Measures of physical performance and risk for progressive and catastrophic disability: results from the Women's Health and Aging Study. J Gerontol A Biol Sci Med Sci. 2005;60:74–9.
40. Montero-Odasso M, Schapira M, Soriano ER, Varela M, Kaplan R, Camera LA, et al. Gait velocity as a single predictor of adverse events in healthy seniors aged 75 years and older. J Gerontol A Biol Sci Med Sci. 2005;60:1304–9.
41. Griffin SF, Wilcox S, Ory MG, Lattimore D, Leviton L, Castro C, Carpenter RA, Rheaume C. Results from the Active for Life process evaluation: program delivery fidelity and adaptations. Health Educ Res. 2009 Mar 26.