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Predictors Of Improvement In Physical Function In Older Adults In An Evidence-Based Physical Activity Program (Enhancefitness)

Sarah Fishleder, PhD[1,2], **Miruna Petrescu-Prahova, PhD**[1,2], **Jeffrey R. Harris, MD**[1,2], **Brian Leroux, PhD**[3,4], **Kimberly Bennett, PhD**[5], **Christian D. Helfrich, PhD**[2], **Marlana Kohn, MPH**[1], **Peggy Hannon, PhD**[1,2]

[1]Health Promotion Research Center, University of Washington, Seattle, WA

[2]Department of Health Services, University of Washington, Seattle, WA

[3]Department of Biostatistics, University of Washington, Seattle, WA

[4]Department of Oral Health Sciences, University of Washington, Seattle, WA

[5]Department of Rehabilitative Medicine, University of Washington, Seattle, WA

Abstract

Background and Purpose—Declines in strength, flexibility and balance in older adults can lead to injuries and loss of independence, and are particularly common in those of greater age and in worse health. Enhance®Fitness (EF) is a nationally disseminated, evidence-based group exercise program for older adults that has been shown to improve function through cardiovascular, strength, flexibility and balance exercises. This paper examines changes in, and predictors of, participant physical function from baseline through 2 program cycles of EF as measured by 3 physical function tests: arm curls, chair stands, and eight-foot up-and-go.

Methods—We analyzed data on participants that attended at least 2 consecutive 16-week program cycles between January 2005 and June 2016. We ran 3 random effects linear regression models, 1 for each physical function test, and accounted for missing data and clustering by class site. Independent variables included attendance, demographics, and health status.

Results and Discussion—A total of 7,483 participants completed baseline and 2 sets of follow-up physical function tests. For all 3 physical function tests, participants showed some degree of improved physical function at each follow-up, and greater program attendance predicted clinically significant improvements. Some participants had less improvement: females, those less active at baseline, above age 75, not married or partnered, or in fair or poor health, those that had experienced at least 1 fall, and those with a disability.

Address correspondence to: Sarah Fishleder, PhD Health Promotion Research Center, Department of Health Services, University of Washington, 1107 NE 45th St, Seattle, WA 98105, Phone: 206-543-2891 • Fax: 206-543-8841 sfishled@uw.edu.

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Conclusion—EF program providers may need to implement additional measures to support the participants that could benefit most from EF, such as targeting messaging, coordinating with referring providers to emphasize attendance and general activity in specific participants, and offering additional support to groups that show less improvement during classes. The evidence presented here may inform clinical decision-making for older adult patients, and increase healthcare provider confidence in EF and similar exercise programs, thereby providing a mechanism to maintain and continue functional gains made in clinical or rehabilitation settings.

Keywords

exercise therapy; aging; disease prevention programs; health behavior

INTRODUCTION

Aging and other health conditions are associated with a decline in physical function.[1] Engaging in multiple types of physical activity can help older adults retain balance, strength, physical function,[2–4] the ability to perform activities of daily living (e.g., bathing, dressing, using a toilet, and eating), and independent living.[5–7] Community-based exercise programs help older adults reach recommended physical activity levels.[8–10] Unfortunately, physical activity cannot always prevent declining physical function for older adults in worse health (e.g., frailty).[11,12] It is important to identify groups at risk for the least improvement to appropriately target additional support.

Enhance®Fitness (EF) is an evidence-based, low-cost, community group exercise program for older adults (aged 65 and above), shown to improve physical function.[13–16] EF is accessible at multiple levels of health and function,[17] and is available nationally, with 736 current sites in 41 states across the U.S. and Washington D.C.[18] Effective June 2017, EF is also approved as an evidence-based fall prevention program by the National Council on Aging (NCOA), which qualifies it for use of federal dollars. More information is available at the program's website (http://www.projectenhance.org) or at the NCOA's website (https://www.ncoa.org/resources/enhancefitness-program-summary/). Participation in all 3 1-hour sessions offered weekly provides enough physical activity to meet the weekly physical-activity levels (i.e., 150 minutes of moderate or 75 minutes vigorous intensity aerobic activity, and 2 days of muscle strengthening) recommended by the Department of Health and Human Services (DHHS) and the Centers for Disease Control and Prevention (CDC).[9]

EF participants previously identified social connection and improved general health as motivators to attendance, and health conditions (e.g., pain and arthritis) as barriers.[15,19] Although improved health is a motivator for sustained participation in EF[15,19], no specific analyses have been conducted to determine if all participants benefit from EF, or if benefit varies by individual characteristics such as age, health and disability.

The purpose of this paper was to examine changes in, and predictors of, participant physical function from baseline through 2 program cycles of EF as measured by 3 physical function tests: arm curls, chair stands, and eight-foot up-and-go. We examined the association between changes in physical function with EF attendance and participant-level characteristics.

METHODS

Program Description

The EF program provides multiple types of physical activity in a structured format. Classes meet for 60 minutes, 3 times a week, and are taught by certified instructors. Project Enhance strongly recommends affiliate organizations' instructor candidates have a primary fitness certification or experience in physical therapy, occupational therapy or nursing prior to attending the 12-hour in-person EF New Instructor Training certification. EF certification includes 3 pre-training modules and a 1.5-day in-person certification. EF Master Trainers support EF instructors through new instructor training, mentoring and fidelity monitoring. Pre-requisites to EF Master Trainer training include 1 year teaching EF to fidelity and a National Commission for Certifying Agencies (NCCA) accredited fitness certification or degree. Continuing education for all EF instructors entitled "Essentials for EF Instructors" is available through Project Enhance's American Council on Exercise portal (http://www.projectenhance.org/EnhanceFitness/Enact.aspx), available online only to certified EF Instructors. The purpose of continuing education is to support the continued development of skills, and maintain certification. Most EF classes are taught on an ongoing basis, but some are offered in 16-week increments (hereafter referred to as a "program cycle"). Classes include cardiovascular, strength, flexibility and balance exercises. Exercises may be done sitting, standing, or standing with support. The program measures 3 areas of physical function, each via its own test: upper-extremity strength (measured by arm curls), lower-extremity strength (measured by chair stands) and a composite test of abilities, including strength, dynamic balance, mobility, and gait (hereafter shortened to 'balance & mobility'; measured by eight-foot up-and-go).[20]

Study Design and Dataset

The dataset consisted of EF program data collected regularly from January 2005 to June 2016. Certified EF program instructors collect participant data, which are entered into an online database, the Online Data Entry System (ODES). ODES is maintained by the licensor of EF, Sound Generations (https://soundgenerations.org), a non-profit social services organization in Seattle, WA. This study was conducted under the approval of the University of Washington Institutional Review Board; the study used fully de-identified secondary data and was classified as exempt.

The initial dataset had 25,584 participants. Our exclusion criteria addressed several potential problems with the data, and retained 30% of the original sample. First, we excluded participants who did not have any follow-up data after baseline (n=14,050; 54.9%). There was also extreme variation in the time between the first and second physical function tests, ranging from 4 weeks to 11 years. Therefore, we excluded participants whose second physical function test date was more than 6 weeks deviant from the EF-defined program cycle (n=4,052; 15.8%). For example, we dropped participants with more than 22 weeks between tests. Last, because there was a large drop in attendance after the second program cycle, we included only the first 3 physical function tests. Put differently, sample participants had at least 2 test scores (baseline and the first program cycle), but may have had up to 3 test scores (a second program cycle). The final sample includes 7,483 (29.2%) participants.

Such heavy exclusions eliminated the possibility of analyzing the benefit of long-term involvement, and may have introduced selection bias (discussed further in the limitations section). To test for this bias, we compared the final sample to the excluded participants using logistic regression.

Variables of Interest

Physical Function—After pilot-testing the feasibility of integrating the Functional Fitness Test into program operations, the EF program developers retained an adapted version of Rikli & Jones's original Functional Fitness Test. The adaptation consists of 3 of the 7 tests in the original Functional Fitness test, and enables feasible integration of the test into the EF program[16]. This adapted version is a validated measure of 3 types of physical function: upper extremity strength, lower extremity strength, and balance & mobility[16]. Content validity of the Functional Fitness Test has previously been established using literature review and expert opinion; each test demonstrated test-retest reliability; and all tests are able to discriminate between regular exercisers and non-exercisers.[20] Physical function tests were collected by certified EF instructors at enrollment and after the first program cycle (4 months, or 48 total classes). About 85% of programs conducted an additional physical function test after the second program cycle (8 months, 96 total classes).

Upper extremity strength was measured by arm curls. This was the number of times a weight could be lifted in a 30-second time period. Women used a 5-lb weight, while men used an 8-lb weight. More repetitions indicated greater strength. The minimal detectable change (MDC) for arm curls has been calculated to be 2.3 repetitions.[21] There is currently no minimal clinically important difference (MCID) available for this test.

Lower extremity strength was measured by thirty-second chair stands. In this test, participants were asked to stand up and sit down without using their arms from a 17-inch tall chair, as many times as possible in 30 seconds. More repetitions indicated greater strength. The MCID has been calculated at 2.0 repetitions.[22] The MDC for chair stands has been calculated to be 2.0 repetitions.[21]

Balance and mobility was measured by the eight-foot up-and-go test. Participants were asked to stand up from a 17-inch-tall chair, walk as quickly as they could for 8 feet, turn, walk back, and sit back down in the chair. This adjustment from the traditional 3-meter distance was made because many facilities did not have the space to accommodate the extra distance. However, the 8 foot distance performs the same in tests of reliability and accuracy[20]. Times are measured in seconds and rounded to 1 decimal place. Fewer seconds elapsed (i.e., faster times) indicated greater balance and mobility. The MDC for the eight-ft up-and-go has been calculated to be 1.4 seconds.[21] There is currently no MCID for this test.

A nationwide study established normative physical performance scores in the Functional Fitness Test. Normal scores were generated separately for each sex and 5-year age interval, and defined by the middle 50% of the study population (see Appendix Table 1).[23] Those scoring above this range would be considered above average for their age, and those below the range as below average. Those with missing age or gender data would be categorized as undefined[23,24] Our analysis used the raw function test scores for clinical interpretability. We discussed normative age and sex ranges for the data descriptively in the following sections, and included this variable in the model to provide information on how categorical baseline scores predicted benefit from EF.

Attendance Variable

Weeks attended: Attendance was logged every session by EF program instructors. We divided the total count of sessions attended in each program cycle by 3 (the number of sessions available per week). The attendance variable represents the number of times the participant attended 3 sessions. It also represents the number of completed weeks of attendance, and the number of times the participant met recommended weekly physical-activity levels. Analyzing attendance in this format enabled us to gain more interpretable coefficients in the model and match the per-week format of the DHHS and CDC physical-activity recommendation.

Demographic Variables—Demographic variables include age (years), sex (male, female), race (White, Black/African-American, American Indian/Alaska Native, Asian, Hawaiian Native/Pacific Islander, 2 or more races), ethnicity (Hispanic, not Hispanic), and marital status (married/partnered, other). These variables were gathered via a standardized form upon enrollment.

Health Status Variables—Health status variables were gathered on a standardized form at enrollment and after the first program cycle (4 months, or 48 total classes). Our analysis used only the baseline data-point for ease of interpretability.

Self-reported comorbidities: A checklist of 6 conditions asked, "Have you ever been told by a doctor or other health professional that you have any of the following conditions? Mark all that apply." Options included: hypertension/heart disease, arthritis/rheumatic disease, diabetes/pre-diabetes, asthma/lung disease, depression, cancer.

Disability: This item asked, "Do you consider yourself to be a person with a disability?" Answer options were disabled or not disabled. A second question related to disability was tested for significance, and dropped (see Data Analysis Strategy section below).

Overall health: The single-question SF-1 asked participants to rate their self-reported general health on a 5-point scale from poor to excellent. For this analysis, results were dichotomized at the frequently used cut-point: Poor or Fair, versus Good, Very Good or Excellent.[25]

Number of physically active days: A single question gathered at baseline asked, "Including the days that you go to EnhanceFitness class, how many days per week do you do physical activity that is about as hard as EnhanceFitness exercises, for 30 minutes or more?" For this analysis, response choices were dichotomized at 0–3, and 4 or above.

Number of falls: A single question asked participants, "How many times have you fallen to the ground in the past 4 months? (Include falls where any part of your body above the ankle hit the ground and falls that occurred on stairs.)" For this analysis, response choices were dichotomized at zero falls, and 1 or more falls.

Data Analysis Strategy—We examined the association between physical function test scores, participant-level predictors, and program attendance using 3 longitudinal random effects linear regression models. Random effects models can account for the clustering of similar results across class sites (i.e., intragroup correlation). We controlled for baseline test performance, and test specifications (i.e., weight used for arm curls, assistive device used for walking). We conducted all analyses in STATA 13.1.

Our models were as simple as possible, while accounting for intragroup correlation and missing data. To account for intragroup correlation, we used random intercepts for EF class sites (n=556), a random effects method that can help estimate the variation of the results due to the class sites. To account for unreported data without losing more of our sample, we used indicator variables for missingness in unordered categorical predictors (i.e., a separate category "missing" was created). This is a simple and useful approach to dealing with missing data,[26] and because we had a relatively homogenous group (i.e., older adult exercise program participants), there were likely common reasons for missing data.

There were 2 survey question variables that were not significant in any model: the participants' education, and if the participant felt that their disability limited their activities. In sensitivity analyses, we compared model results with and without the missing indicator categories, and the 2 non-significant variables. There were no meaningful differences in the results. Therefore, we dropped the 2 non-significant variables and present the final model in the Results below.

RESULTS

Study Sample

Most of the 7,483 sample participants (Table 1) were between the ages of 65 and 75 years (52%), female (81%), White (62%), and not married or partnered (44%). Most did not have a disability (84%), were in at least good health (83%), and had not experienced any falls in the last 4 months (71%). The mean attendance for the first program cycle, and the physical function test scores for baseline and first follow-up are presented by demographic variables in Table 2. Some degree of improvement was observed in every subgroup, but many of the listed changes did not meet the MDC until the second follow-up.

We found statistically significant, but weak (OR<1.1) associations between being in the final sample, and not being disabled, being more active, and being in better health. We found a stronger association (OR: 2.2) between Asian race and being in the final sample.

Overall Trend of Physical Function

The mean number of complete weeks of EF attendance (i.e., the number of weeks the participant attended 3 sessions) in the first program cycle was 10.6.

The mean performance on the physical function tests at baseline was 16.5 arm curls (of which 48% were in the normal range for their age-sex category);[23] 12.4 chair stands (57% in normal range), and 8.8 seconds for the eight-foot up-and-go (40% in normal range) (Table 3). Total mean improvement was 2.7 arm curls, 2.1 chair stands, and 1.1 seconds on the eight-foot up-and-go tests. These improvements were statistically significant in all 3 tests ($p<0.001$) at each follow-up (Figure 1).

Normative data showed shifts to higher-performing categories in all physical function tests (Table 3). For example, for arm curls from baseline to the first program cycle (4 months), the number of people in the below-normal category shrank from 14% (n=1,055) to 7% (n=513), those in the normal category shrank from 48% (n=3,551) to 40% (n=2,757); while those in the above-normal grew from 35% (n=2,587) to 50% (n=3,440).

In the regression models, every additional complete week of EF class attendance per program cycle (each week of reaching the DHHS and CDC recommended physical activity levels) was statistically associated with an improvement in upper extremity strength (0.16 additional arm curls, $p<.001$), lower extremity strength (0.12 additional chair stands, $p<.001$) and balance & mobility (0.08 second reduction in time for the eight-foot up-and-go, $p<.001$) (Table 4).

Association of Physical Function with Person-level Predictors

Statistically significant associations between changes in each physical function test (the dependent variables in 3 different regression models that included attendance) and person-level predictors are presented below. We focused on those that were significantly associated in the desired direction (i.e., increased for arm curls and chair stands, decreased for eight-foot up-and-go) with at least 2 of the 3 physical function tests (Table 4) to emphasize the findings with the strongest evidence.

Age and Health Related Predictors—The strongest predictors of change in physical function included: being above age 75 or above age 85 (as compared to 65–75); being in fair or poor health; having a disability; and having had at least 1 fall. Older age, health status, and disability status were associated with less upper-body strength (range, 0.33 to 1.29 fewer arm curls, $p<0.001$), less lower-body strength (range, 0.24 to 0.84 fewer chair stands, $p<0.001$), and worse balance & mobility (range, 0.49 to 1.57 additional seconds, $p<0.001$) per program cycle. Having had 1 or more falls at baseline was associated with less upper body strength (0.37 fewer arm curls, $p<0.001$) and less lower body strength (0.15 fewer chair stands, $p=0.02$).

Because increasing age, poorer health and presence of disability are often associated with continued decline of physical function, we sought to determine if the physical function of these subgroups ultimately improved. We tested this by fitting all 3 models with interaction terms for each predictor at baseline (age group, health status, disability) and time. We found 2 weak interactions that reached significance, both within the chair stand model. Improvements were slightly greater among those who had not experienced a fall (β: 0.0002, $p=0.03$), and those aged 65–75 (as compared to the 2 older age groups) (β: 0.008, $p=0.03$). Similar amounts of improvement were observed in every subgroup, indicating that even participants with greater age and specific health conditions still showed improvement. This improvement is depicted graphically in the series of charts in Figure 2, and the actual values are presented in Table 2.

Demographic Predictors—Other significant predictors of change in physical function included: not being partnered or married, being less active, and being female. Not being partnered or married and having fewer than 4 physically active days per week were both associated with less upper-body strength (range: −0.17 to −0.18 fewer arm curls, p: 0.02 to <0.001), less lower-body strength (range: −0.19 to −0. 24 fewer chair stands, p<0.001), and less balance & mobility (range: 0.19 to 0.14 additional seconds, p: 0.01 to 0.02). Being female was associated with less upper body strength (0.32 fewer arm curls, p<0.001) and less lower-body strength (0.17 fewer chair stands, p<0.01).

Baseline Performance Category—We also tested how the participant's baseline performance category predicted benefit from EF. In upper extremity strength, those with a categorical baseline performance above normal showed more improvement (0.4 additional arm curls, p=.02) as compared to those in the normal category. In balance & mobility, those with a categorical baseline performance below normal showed less improvement (0.52 additional seconds, p<.001) as compared to those in the normal category. No other statistically significant differences were found across categories of baseline performance.

DISCUSSION

In summary, EF participants showed statistically and clinically significant improvements in physical function (as measured by upper and lower extremity strength, and balance & mobility) from baseline through 2 program cycles. Less improvement was associated with being female, less active at baseline, above age 75, not married or partnered, in fair or poor health, having 1 or more falls, and having a disability. This study added to the evidence about the EF program across groups, and identified participants whose gains from the program could be increased. The results may be applicable to other types of structured exercise programs for older adults, such as Fit and Strong! or Geri-Fit. EF and similar exercise programs may be able to provide additional support for the groups identified here, and the evidence presented may inform clinical decision-making for older adult patients.

Physical Function Improvement Across All Follow-ups

Greater EF attendance was associated with improved physical function. Results were consistent with previous EF research,[16,27] and the well-documented association between exercise attendance and physical function.[28–30]

The mean attendance for the first program cycle was 10.6 complete weeks out of 16 possible. This adherence rate of 66% was similar to mean rates of other interventions, which a systematic review noted range from 58% to 77%.[31] Although this sample was generally adherent to the EF program, there was still a significant association between improved physical function and attendance. This was important because our inclusion criteria constrained variation in attendance among participants. This suggests that even small increases in attendance of EF and other types of structured exercise programs, can benefit physical function.

Results appeared to be clinically significant, as evidenced by 2 metrics: the MDC and MCID values, and improvements in normative performance categories. First, for the MDC and MCID metric, the total mean improvement on arm curls (2.7 repetitions) met the MDC criteria of 2.3 repetitions on the second follow-up. The total mean improvement on chair stands (2.1 repetitions) met the MDC criteria of 2.0 repetitions on the second follow-up, and the MCID criteria of 2.0 repetitions on the second follow-up. The total mean improvement on the eight-ft up-and-go (1.1 seconds) approached the MDC criteria of 1.4 seconds on the second follow-up. There are currently no MCID available for the arm curl and eight-foot up-and-go tests. Second, for the age and sex normative categories metric, EF participants shifted to higher performance categories across each program cycle. For example, those in the above normal category for arm curls grew by 14.9% (n=853), while those in the normal category shrank by 7.9% (n=794). Complete details of these categorical shifts are presented in Table 3.

The baseline performance category did not consistently predict improvement; that is, those performing below norms at baseline did not necessarily experience less improvement than higher performing participants. This finding adds evidence to the potential of EF and similar types of structured exercise programs to benefit older adults with all levels of function. It also suggests that those in the lower-functioning category could improve at levels comparable to their better-functioning peers. These continued gains are important because some programs for older adults are not associated with a reduction in functional decline.[12]

Groups with the Least Improved Physical Function

Our results were not surprising, as the demographics and health conditions we found to be associated with less improvement have an intuitive association with lower physical function. Further, the self-report of worse health, falls, and disability has been associated with lower function[1]. Our results were not likely due to differences in attendance or baseline performance, because we controlled for these in the models. We also controlled for a list of comorbidities. However, it is possible that these variables may not have fully accounted for the potential effects of the health condition. Nonetheless, groups with worse health, older age, more falls, and a disability still appeared to show improvement, as evidenced by the weak or non-significant interactions with time, and the improved mean scores. This improvement is important. Two systematic reviews found some interventions were not associated with functional improvements among older adults in worse health, and those that were linked to improvement had highly variable effect sizes.[11,12] Unexplained differences in EF effectiveness may be due to discomfort with the environment or the instructor (known as proxy efficacy[32]), a lack of individual engagement during class sessions, and health or knowledge barriers not captured in the model. These results likely apply to other types of structured exercise programs.

Implications

We found identifiable subgroups who have the most to gain from EF. Targeted efforts to provide additional support for subgroups of older age, and with specific demographics and health conditions that participate in EF and similar programs could yield high dividends in improved physical function.

Strategically Reaching Out to Groups at Risk—In this model, 2 predictors of physical function examined were behavioral (i.e., activity level and attendance), and therefore can be controlled by the participant. EF and similar programs could target messaging and attempt to support or incentivize those behaviors. We found that improvements in physical function were driven by even small improvements in attendance. Previous qualitative data suggest social connection motivates attendance. Therefore, focusing on relationship building may be useful to increase activity in and out of the program. Examples of strategies include establishing a buddy system or phone tree to increase accountability, and including members of older adults' social network to motivate attendance.[19,33,34]

For those predictors that were not under participants' control (i.e., demographic variables and health conditions), there are two ways for EF and similar programs to triage efforts: the prevalence of the risk factor, and the strength of its impact. Targeting females (about 80% of the sample) and those who were not partnered (about 44% of the sample) could impact the highest volume of people. It is possible lower gains in these groups reflected the variability that accompanies higher representation in the sample. Nonetheless, strategies to support these groups could include programs providing instructors with training in communication and motivational techniques. Such training could ensure that corrections in exercise form are understood, boost individual engagement, and focus individualized outreach from the instructor or peers.[35–37]

Targeting groups with the strongest associations (i.e., being above age 75, disabled, in worse health, and experiencing more falls) could support participants with the most to gain, and maximize the public health benefits of the program. Strategies could include accommodating health problems that prevent engagement, optimizing treatment of pain or stiffness, instruction in energy conservation techniques, and gradated entry into regular exercise.[33]

Increasing Number of Program Completers—The high numbers of participants who only contributed baseline data suggested high attrition rates. Alternatively, it was possible that participants stayed in the program but avoided the physical function test days. EF instructors have reported this anecdotally. If these participants have different performance profiles, our results may misstate the amount of improvement

Adjustments in program delivery using strategies identified in previous research may help retain and encourage attendance in EF and similar programs, even on test days. Strategies include adjusting marketing (e.g., highlight personal gains, low cost, and unique program features) and simplifying logistics (e.g., times and location). In addition, although all EF classes have the same format and exercises within the 1-hour session, variations in music and slight changes in the difficulty of exercises are possible depending on the characteristics of participants in each class.[19,33,34] Another strategy to retain and encourage attendance may be to gain the confidence of referring clinicians by promoting the characteristics of program participants, and the overall improvements of a population often expected to decline. Trust built between the program and referring clinicians through evidence can be a motivator in making the decision to refer.[38]

The same health factors that predicted reduced performance (i.e., worse health, experiencing falls, and having a disability) also have been identified as both motivators and barriers to EF attendance.[39] Instructors and peers could re-emphasize the program's effectiveness and modifiability, and help encourage participants through the barriers of chronic health conditions.[19,33,34]

Strengths, Limitations, and Directions for Future Research

Our study had several strengths, including using a large sample of routinely collected program data from real-world settings, and looking at the same individual over time with multiple measurements. We included only participants with completed intervention cycles to avoid categorization bias. However, this limited the results to a select sample, and we could not draw conclusions about participants who did not provide a follow-up fitness check. However, the difference between those in the analytic sample and those who only contributed baseline data is likely to be minimal in the real-world setting, as the only statistically significant differences were very weak (with the exception of Asian race). We also could not control for reverse causation, and some variables lacked context. For example, the falls variable did not include a cause; so participants could have fallen for a multitude of reasons, such as vestibular disease, vision impairment, decreased strength or reflexes, or even from high-intensity athletic activities. One additional consideration is variable program fidelity, however a previous study found that EF maintains core elements of the tested intervention and has mechanisms to track and enhance fidelity (e.g., instructor certifications, participant program manuals, and periodic reviews with Master trainers).[40]

Future qualitative research could attempt to learn how to better support participants throughout their time in the program, and identify site-specific barriers to effectiveness, which are likely highly variable. Evaluation modifications could include collecting data to directly identify underlying barriers to the program's effectiveness. Additional analysis may use methods such as structural equation models to see the complex web of associations more accurately, or examine specific improvement trajectories of subgroups. Another analysis may determine if test days deter attendance, which may bias results. Finally, not all the physical function tests had MCID values available for the general population of older adults. Research should be conducted to establish MCID values so clinicians and researchers have a threshold though which to identify clinically important changes.

CONCLUSION

This paper examined changes in, and predictors of, participant physical function from baseline through 2 program cycles of participation in EF. We found that EF attendance was associated with clinically important improvements in physical function in older adults, with increased improvement across follow-ups with higher attendance. The groups of older age, and with specific demographics (i.e., being female, less active at baseline, and not married or partnered), and health conditions (i.e., worse health, experiencing falls, and having a disability) that were at risk of fewer improvements were not surprising, given previous literature; yet these groups still showed improvement overall. Results highlighted the need to continue to understand and address barriers to improvement. Implications for EF and similar programs include targeting messaging, coordinating with referring providers to emphasize attendance and general activity in specific participants, and offering additional support to at-risk groups during classes. The evidence presented here may inform clinical decision-making for older adult patients, and increase healthcare provider confidence in exercise programs such as EF, thereby providing a mechanism to maintain and continue functional gains made in clinical or rehabilitation settings.

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Appendix

Appendix Table

Normal Range of Physical Function Test Scores by Gender and Age Groups as Defined in Rikli & Jones 1999[23]

Age Category	Arm Curls (number of reps)				Chair Stand (number of stands)				8-Ft Up and Go (seconds)			
	Men		Women		Men		Women		Men		Women	
Aged 60–64	16-	22	13-	19	14-	19	12-	17	5.6-	3.8	6.0-	4.4
Aged 65–69	15-	21	12-	18	12-	18	11-	16	5.7-	4.3	6.4-	4.8
Aged 70–74	14-	21	12-	17	12-	17	10-	15	6.0-	4.2	7.1-	4.9
Aged 75–79	13-	19	11-	17	11-	17	10-	15	7.2-	4.6	7.4-	5.2
Aged 80–84	13-	19	10-	16	10-	15	9-	14	7.6-	5.2	8.7-	5.7
Aged 85–89	11-	17	10-	15	8-	14	8-	13	8.9-	5.3	9.6-	6.2
Aged 90–94	10-	14	8-	13	7-	12	4-	11	10.0-	6.2	11.5-	7.3

Rikli & Jones 1999 defined normal range of scores for women, with normal defined as the middle 50% of the population. Those scoring above this range would be considered above average for their age and those below the range as below average. Further information can be found in the complete article[23].

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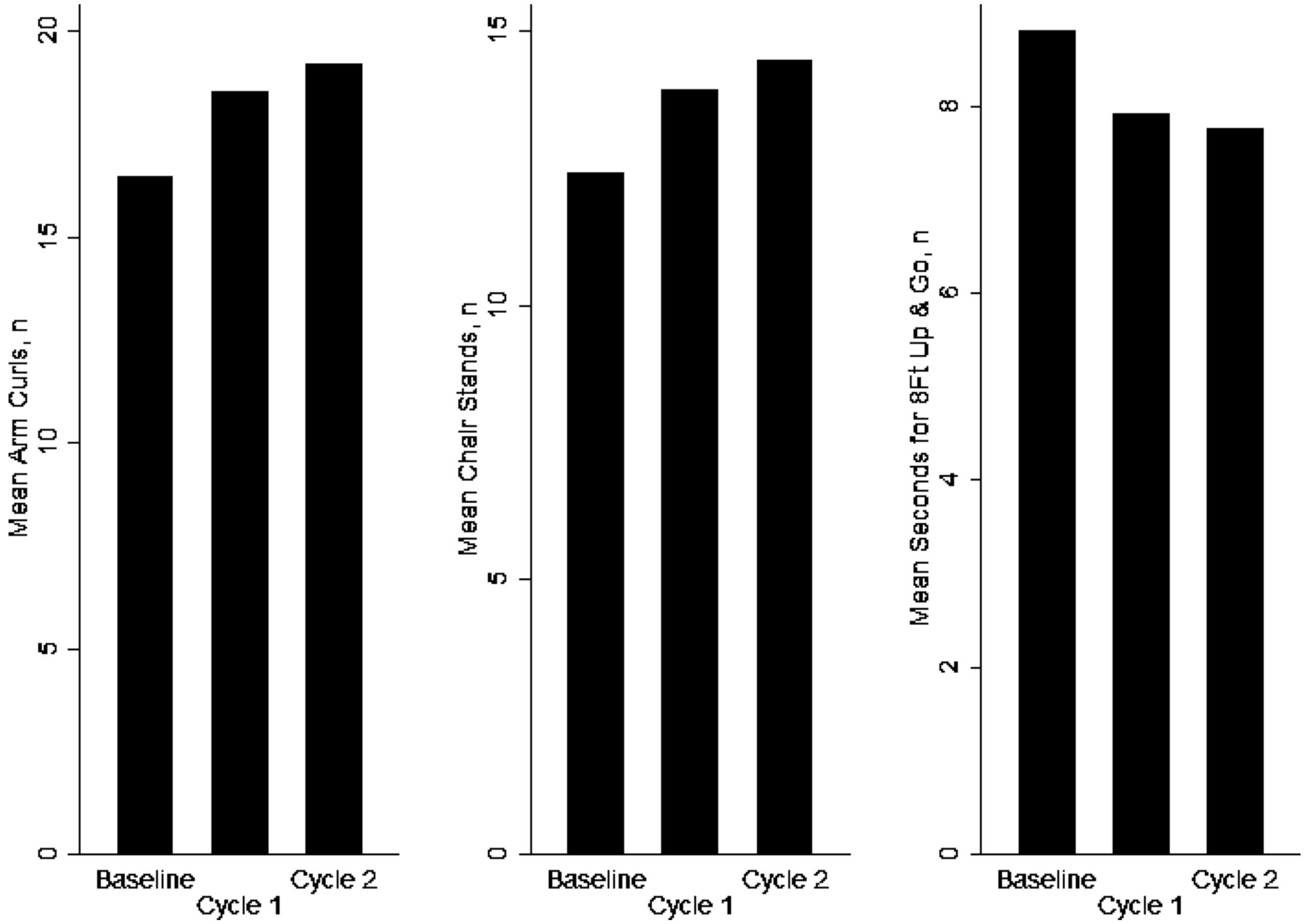
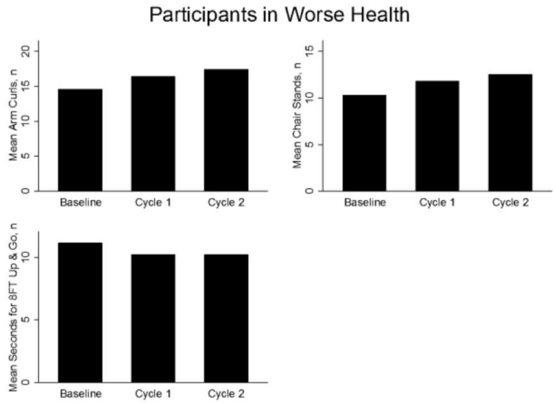
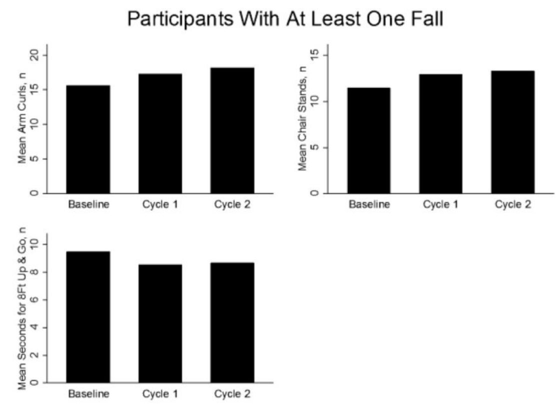
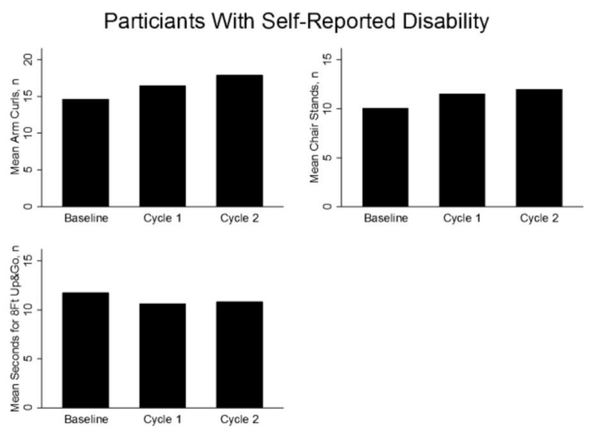


Figure 1. Mean Physical Function Test After Each EF Program Cycle Among Participants Enrolled 2005–2016

Improvement in arm curls and chair stands is indicated with higher scores. Improvement in 8-ft up and go is indicated with lower times.


Participants in Worse Health
Mean Arm Curls, n
Mean Chair Stands, n
Mean Seconds for 8FT Up & Go, n
Baseline
Cycle 1
Cycle 2


Participants With At Least One Fall
Mean Arm Curls, n
Mean Chair Stands, n
Mean Seconds for 8Ft Up & Go, n
Baseline
Cycle 1
Cycle 2


Particiants With Self-Reported Disability
Mean Arm Curls, n
Mean Chair Stands, n
Mean Seconds for 8Ft Up&Go, n
Baseline
Cycle 1
Cycle 2

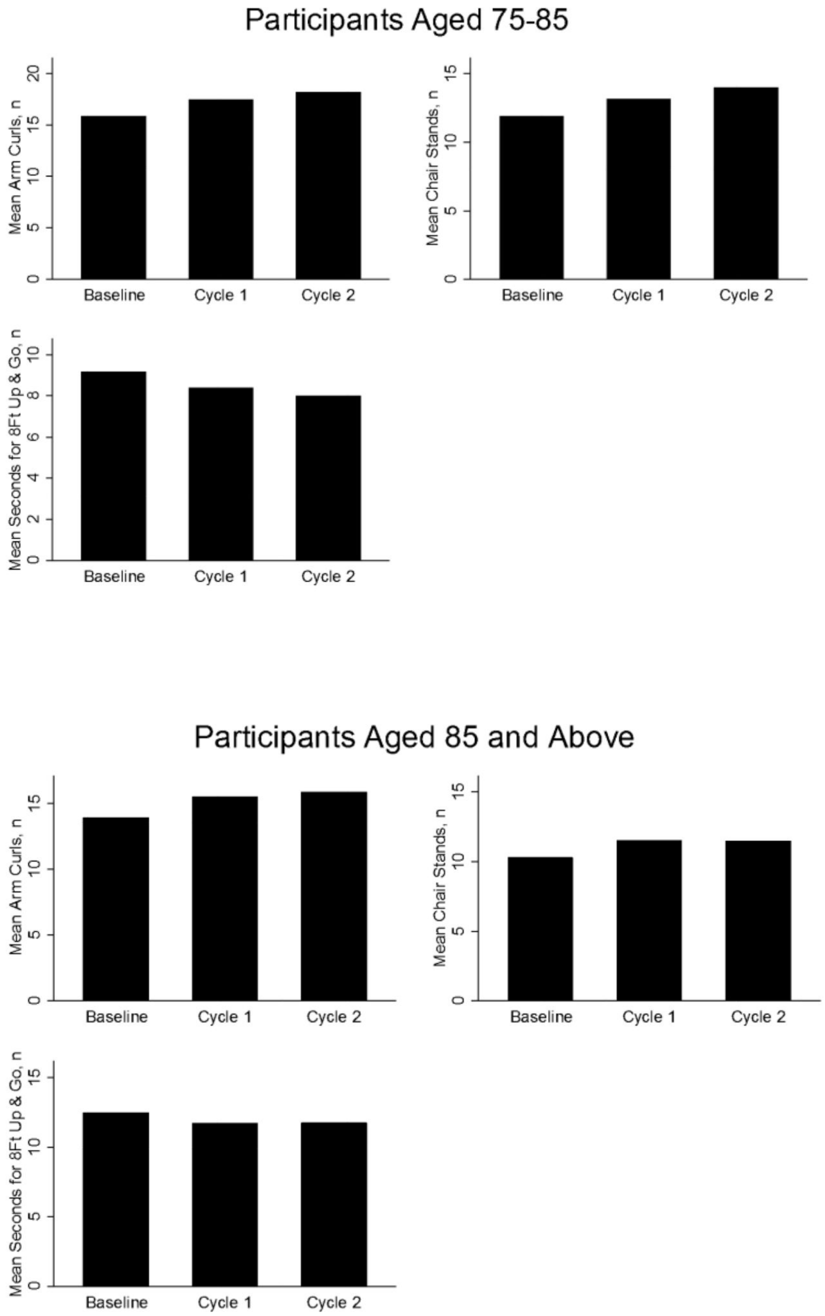


Figure 2. Mean Physical Function Test by Significant Health Predictor After Each EF Program Cycle Among Participants Enrolled 005–2016

Improvement in arm curls and chair stands is indicated with higher scores. Improvement in 8-ft up and go is indicated with lower times.

Table 1

Overview of Demographics of EnhanceFitness Participants Enrolled 2005–2016 from Baseline to 8 Months

Demographic Characteristic	All Participants (n=7,483)	
	n	%
Gender (n=7,408)		
Male	1,327	17.7
Female	6,081	81.3
Marital status (n=5,962)		
Married or partnered	2,706	36.2
Widowed, divorced, single or separated	3,256	43.5
Age (n=7,334)		
65–75 years	3,830	52.2
75–85 years	2,705	36.9
85 years and above	799	10.9
Race (n=6,301)		
White	4,643	62.1
Black/African-American	811	10.8
Native American	97	1.3
Asian/Asian-American	541	7.2
Native Hawaiian/Pacific Islander	26	0.4
Two or more races	183	2.5
Hispanic ethnicity (n=6,298)	381	5.1
Disability (n=5,928)	1,191	15.9
Self-reported health at baseline (n=7,030)		
Excellent/very good/good	6,205	82.9
Fair/poor	825	11.0
Number of falls at baseline (n=6,317)		
None	5,285	70.6
One or more	1,032	13.8
Number of physically active days at baseline (n=5,731)		
Zero to three days	3,762	50.3
Four or moredays	1.969	26.3
Chronic diseases present		
Hypertension or heart disease (n=6,551)	2,506	33.5
Arthritis or rheumatic disease (n=6,227)	2,394	32.0
Diabetes or prediabetes (n=6,324)	925	12.4
Asthma or lung disease (n=6258)	445	6.0
Depression(n=6,261)	431	5.8
Cancer (n=6,302)	740	9.9

Table 2

Mean Physical Function Test Scores and Attendance by Demographics of EnhanceFitness Participants Enrolled 2005–2016 in the First Program Cycle

Demographic Characteristic	Weeks of Attendance (n=7,483)	Number of Arm Curls, n (n=6,389)		Number of Chair Stands, n (n=6,279)		Eight-Foot Up & Go Time, (s) (n=6,315)	
		Mean		Mean		Mean	
	Mean	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Gender							
Male	11.2	17.7	19.9	12.9	14.6	8.7	7.7
Female	10.5	16.1	18.2	12.3	13.8	8.8	8.0
Not reported	9.9	19.7	20.4	13.6	15.2	8.2	7.3
Marital status							
Married or partnered	10.9	17.0	19.2	12.9	14.7	7.8	7.0
Widowed, divorced, single or separated	10.8	15.6	17.6	11.8	13.3	9.4	8.4
Not reported	9.7	17.5	19.3	12.8	14.1	9.3	8.5
Age							
65–75 years	10.5	17.3	19.8	13.2	15.0	7.8	6.9
75–85 years	10.7	15.8	17.6	11.8	13.2	9.1	8.3
85 years and above	10.9	13.9	15.4	10.3	11.5	12.5	11.8
Race							
White	10.7	16.4	18.4	12.3	13.9	8.4	7.5
Black/African-American	9.8	17.7	20.1	11.9	13.0	10.4	9.6
Native American	9.5	16.5	18.2	12.3	14.0	8.7	7.9
Asian/Asian-American	12.2	14.0	15.9	12.9	15.1	8.6	7.9
Native Hawaiian/Pacific Islander	13.0	13.9	16.5	10.4	14.2	10.0	8.2
Two or more races	11.2	16.0	17.9	12.6	14.3	9.7	8.3
Not reported	10.0	17.5	19.3	13.0	14.3	9.2	8.3
Hispanic ethnicity							
Not Hispanic	10.8	16.2	18.3	12.2	13.9	8.8	7.8
Hispanic	10.1	17.4	19.4	13.4	14.9	8.7	7.9
Not reported	10.0	17.6	19.3	13.1	14.3	8.9	8.4

Demographic Characteristic	Weeks of Attendance (n=7,483)	Number of Arm Curls, n (n=6,389)		Number of Chair Stands, n (n=6,279)		Eight-Foot Up & Go Time, (s) (n=6,315)	
		Mean		Mean		Mean	
	Mean	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Disability							
No disability	10.9	16.7	18.8	12.8	14.5	8.0	7.1
Disability	10.9	14.5	16.5	10.0	11.6	11.9	10.6
Not reported	9.7	17.3	19.2	12.9	14.2	8.9	8.3
Self-reported health at baseline							
Excellent/very good/good	10.7	16.6	18.7	12.7	14.2	8.4	7.6
Fair/poor	10.4	14.7	16.6	10.3	12.0	11.2	10.2
Not reported	9.9	17.3	19.2	12.5	14.5	9.8	8.6
Number of falls at baseline							
None	10.8	16.6	18.7	12.6	14.1	8.7	7.8
One or more	11.0	15.6	17.5	11.5	13.1	9.4	8.5
Not reported	9.7	16.8	18.8	12.4	14.2	8.8	8.0
Number of physically active days at baseline							
Zero to three days	10.5	16.3	18.1	12.2	13.5	9.0	8.3
Four days or more	11.2	17.2	19.0	13.1	14.6	8.3	7.5
Not reported	9.6	15.9	18.7	12.1	14.4	9.0	7.6
Chronic diseases present							
Hypertension or heart disease	10.7	15.7	17.9	11.7	13.4	9.3	8.3
Arthritis or rheumatic disease	11.6	15.7	17.8	11.7	13.3	9.2	8.1
Diabetes or prediabetes	11.0	15.5	17.6	11.5	13.3	9.2	7.9
Asthma or lung disease	10.6	15.5	17.9	11.5	13.2	9.4	8.5
Depression	10.6	15.1	16.9	11.3	12.9	9.1	8.1
Cancer	10.6	15.8	18.1	12.1	13.6	9.0	7.8

Not Reported: This data was missing from the participant's intake survey

Table 3

Mean Physical Function Test Results and Normative Score Category at Each Follow-up of EnhanceFitness Participants Enrolled 2005–2016

Type of Physical Function Test	Score			Jones & Rikli Normative Age & Sex Categories							
		Total Improvement Since Baseline	ANOVA	Below Normal		Normal		Above Normal		Undetermined	
	Mean	Mean	p	n	%	n	%	n	%	n	%
Baseline (n=6,442)											
Number of arm curls	16.5	-	-	1,055	14.1	3,551	47.5	2,587	34.6	290	3.9
Number of chair stands	12.4	-	-	1,545	20.7	4,270	57.1	1,259	16.8	409	5.5
Number of seconds for eight foot up and go	8.8	-	-	3,537	47.3	3,026	40.4	526	7.0	394	5.3
Program cycle one (n=6,442)											
Number of arm curls	18.5 *	2.0	<0.001	513	7.4	2,757	39.6	3,440	49.5	246	3.5
Number of chair stands	13.9 *	1.5	<0.001	839	12.1	3,787	54.4	1,981	28.5	349	5.0
Number of seconds for eight foot up and go	7.9 *	0.9	<0.001	2,4447	35.2	3,348	48.1	825	11.8	336	5.0
Weeks of attendance	10.6	-	-	-	-	-	-	-	-	-	-
Program cycle two (n=1,890)											
Number of arm curl	19.2 *	2.7	<0.001	181	6.1	1,064	35.8	1,641	55.2	85	2.9
Number of chair stands	14.5 *	2.1	<0.001	295	9.9	1,503	51.7	1,022	34.4	119	4.0
Number of seconds for eight foot up and go	7.7 *	1.1	<0.001	959	32.3	1,473	49.6	420	14.1	119	4.0
Weeks of attendance	10.4	-	-	-	-	-	-	-	-	-	-

Significant results are indicated with an asterisk and a p-value of less than 0.05

Table 4

Linear Regression Results of Physical Function Tests and Weekly Attendance of EnhanceFitness Participants Enrolled 2005–2016 from Baseline to 8 Months

Predictor in Regression Model	Arm Curl *n=7.262*			Chair Stand *n=7,118*			Eight-Foot Up & Go *n=7,154*		
	β	(CI)	p	β	(CI)	p	β	(CI)	β
Number of complete weeks attended each cycle (three classes)	0.16*	(0.14–0.17)	<0.001	0.12*	(0.11–0.13)	<0.001	−0.08*	(−0.08–−0.06)	<0.001
Female gender *(ref: male)*	−0.32*	(−0.54–−0.10)	<0.001	−0.17*	(−0.30–−0.04)	0.01	0.06	(−0.07–0.20)	0.90
Not married or partnered *(ref: married or partnered)*	−0.18**	(−0.34–−0.11)	<0.001	−0.19*	(−0.29–−0.08)	<0.001	0.14*	(0.02–0.26)	0.02
Age at baseline *(ref: 65–75 years)*									
75–85 years	−0.76*	(−0.92–−0.59)	<0.001	−0.42*	(−0.52–−0.33)	<0.001	0.49*	(0.37–0.62)	<0.001
Above 85 years	−1.29*	(−1.58–−1.00)	<0.001	−0.84*	(−0.99–−0.66)	<0.001	1.57*	(1.18–1.96)	<0.001
Race *(ref: white)*									
Black/African American	0.66*	(0.16–1.17)	0.01	−0.22	(−0.47–0.02)	0.07	0.52*	(0.18–0.85)	<0.001
Native American	−0.14	(−0.79–0.51)	0.68	0.17	(−0.21–0.56)	0.38	−0.01	(−0.37–0.35)	0.97
Asian/Asian American	−0.41*	(−0.82–−0.01)	0.04	0.65*	(0.35–0.94)	<0.001	−0.05	(−0.32–0.21)	0.70
Native Hawaiian / Pacific Islander	−0.10	(−1.15–0.95)	0.85	0.93*	(0.48–1.38)	<0.001	−0.01	(−0.37–0.35)	0.35
Two or more races	−0.27	(−0.78–0.24)	0.31	0.03	(−0.38–0.38)	0.99	0.15	(−0.42–0.71)	0.61
Hispanic ethnicity *(ref: not Hispanic)*	0.38	(−0.11–0.75)	0.15	0.32*	(−0.02–0.62)	0.04	0.10	(−0.17–0.38)	0.46
Presence of a disability *(ref: not disabled)*	−0.42*	(−0.62–−0.22)	<0.001	−0.40*	(−0.53–−0.28)	<0.001	0.69*	(0.45–0.93)	<0.001
Less than four physically active days *(ref: 4–7 days)*	−0.17*	(−0.34–0.01)	0.04	−0.24*	(−0.34–−0.13)	<0.001	0.19*	(0.04–0.33)	0.01
Self-reported health of poor or fair *(ref: ≥good)*	−0.33*	(−0.56–−0.10)	<0.001	−0.24*	(−0.40–−0.08)	0.01	0.55*	(0.29–0.81)	<0.001
One or more falls at baseline *(ref: no falls)*	−0.37*	(−0.55–−0.20)	<0.001	−0.15*	(−0.29–0.02)	0.02	0.11	(−0.05–0.27)	0.17
Chronic diseases present									
Hypertension or heart disease	−0.06	(−0.22–0.10)	0.45	0.04	(−0.07–0.14)	0.50	0.07	(−0.06–0.20)	0.30
Arthritis or rheumatic disease	−0.10	(−0.26–0.05)	0.18	−0.05	(−0.16– 0.05)	0.32	−0.06	(−0.20–0.08)	0.39
Diabetes or prediabetes	−0.11	(−0.31–0.10)	0.28	−0.17*	(−0.30– −0.04)	0.01	−0.06	(−0.11–0.23)	0.50
Asthma or lung disease	0.09	(−0.21–0.38)	0.56	−0.06	(−0.14–0.25)	0.58	−0.14	(−0.32–0.03)	0.12

Predictor in Regression Model	**Arm Curl** ***n=7.262***			**Chair Stand** ***n=7,118***			**Eight-Foot Up & Go** ***n=7,154***		
	β	**(CI)**	**p**	**β**	**(CI)**	**p**	**β**	**(CI)**	**β**
Depression	−0.33*	(−0.64–−0.04)	0.03	−0.06	(−0.24– 0.13)	0.56	−0.03	(−0.27–0.22)	0.83
Cancer	0.12	(−0.10–0.34)	0.26	−0.02	(−0.18– 0.14)	0.80	−0.07	(−0.23–0.09)	0.42
Baseline performance category *(ref: Normal)*									
Below Normal	0.05	(−0.23–0.32)	0.75	−0.16	(−0.33–0.02)	0.08	0.52*	(0.31–0.72)	0.00
Above Normal	0.40*	(0.06–0.74)	0.02	0.15	(−0.04–0.34)	0.13	−0.05	(−0.31–0.21)	0.71

CI: Confidence Intervals

Significant results are indicated with an asterisk (*) and a p-value of less than 0.05

Regression also includes control variables: test score- weight used- assisted walking device used, physical function test score

Improvement in arm curls and chair stands is indicated with higher scores. Improvement in 8-ft up and go is indicated with lower times

Missing indicator categories for each variable were not significant unless marked in one of the following footnotes:

Marital Status Not Reported, Chair Stands: β (CI): −0.21* (−0.43– −0.01)
Undefined Baseline Performance, Chair Stands: β (CI): −0.83* (−1.53– −0.14)