

Acute Resistance Training May Have Lasting Benefit to Middle-Aged Adults

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Breanne S. Baker, PhD^{1,*}, Majid Mufaqam Syed-Abdul, PhD^{1,*},
Kelsey J. Weitzel, MS¹, and Stephen D. Ball, PhD¹

Abstract

Age-related declines in physical function can be mitigated with resistance training (RT), but most adults do not regularly exercise. We aimed to identify the magnitude and duration of benefits after RT in the Stay Strong, Stay Healthy (SSSH) program. A total of 27 adults (Repeaters $n=15$; Summer Only $n=12$), aged 60.7 ± 4.8 years, completed the same 8 weeks of SSSH in the summer and Repeaters continued in fall and spring months. Independent and paired t -tests and repeated-measures ANOVAs were used to test changes in survey responses and physical performance over 10 months. Both groups were similar at baseline ($p > .07$) and improved from pre- to post-summer for health surveys scores, 30 second-sit-to-stand, timed-up-and-go, and sit-n-reach ($p \leq .02$). Additionally, Repeaters (measured data) and Summer Only (2.3% modeled decline) maintained those improvements 10 months later. Participation in 8 weeks of SSSH significantly improved physical strength and function and these improvements may last up to a year.

Keywords

exercise, falls, mobility, physical function, successful aging

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Introduction

Physical function and muscle strength normally peak around age 20 to 30 years, plateau until the 50s, and then decline at increasing rates per decade thereafter (Frontera et al., 1991). Physical activity effectively combats age-related musculoskeletal declines in older adults (Fragala et al., 2019) but despite this evidence, only about 20% of adults aged 55 to 64 years are meeting weekly national guidelines for aerobic and resistance training (RT) exercises (Administration for Community Living [ACL], 2019). Since, RT has been shown to improve muscle strength, functional performance, and balance more than aerobic training (Villareal et al., 2017), it is logical that RT should be prescribed to adults who are starting their 5th and 6th decades of life.

Many RT programs, such as Stay Strong Stay Healthy (SSSH), specifically target older adults and have been shown to improve muscle strength, flexibility, and balance (Baker et al., 2020, 2021; Ball et al., 2013; Syed-Abdul et al., 2021). Unfortunately, longitudinal studies of the effects of RT are lacking, as most research is cross-sectional or short duration such as eight or 12 weeks. When research participants no longer engage

in the intervention, it makes long-term follow-up difficult; however, one technique that can be used is to model known declines in musculoskeletal capacity. For adults in their 60s it has been reported that musculoskeletal capacity declines at an average of 2.3% per year (Frontera et al., 2000).

Our first aim was to assess the extent older adults' benefit from acute participation in 8 weeks of SSSH. Second, using a linear 2.3% modeled decline, we aimed to understand the duration of benefits from RT that might persist. We hypothesized that SSSH participation would improve older adults' perceived health and physical function in 8 weeks and the positive benefits would be maintained 10 months later.

¹University of Missouri, Columbia, USA

*These are co-first author.

Corresponding Author:

Breanne S. Baker, Department of Orthopaedic Surgery and Thompson Laboratory for Regenerative Orthopaedics, Missouri Orthopaedic Institute, University of Missouri, 1100 Virginia Avenue, Columbia, MO 65212, USA.
Email: bakerbre@health.missouri.edu



Materials and Methods

Participants and Modeling Decline

Retrospective access to deidentified SSSH program data was approved by the University of Missouri Institutional Review Board (IRB #2031903). A total of 27 middle-aged adults (92% female, 60.7 ± 4.7 years) enrolled in the SSSH program during the summer months (Repeaters $n=15$; Summer Only $n=12$). Repeaters also completed the fall and spring 8-week SSSH programs. A linear 2.3% decline was modeled for all performance measures from the pre-fall to the post-spring for Summer Only participants. This simulates their data after they no longer re-enrolled in the SSSH program based on published rates of musculoskeletal decline in this age-group (Frontera et al., 2000).

SSSH Programming

SSSH programming has been described elsewhere (Baker et al., 2020, 2021; Ball et al., 2013; Syed-Abdul et al., 2021), but in summary the program meets in-person two times per week for 60 minutes, with a warm-up and cool-down. All eight exercises are performed at a 2.4 second tempo and include wide leg squat, leg curl, toe stand, side-leg raise, biceps curl, overhead press, bent-over seated row, and knee extension. All instructors have completed formal training from the SSSH program and either have, or are working towards, graduate degrees in Exercise Science, Nutrition, or a related field. For this study, all participants met at the same gymnasium on the University Missouri campus to complete testing and exercise classes.

Surveys and Functional Assessments

Participants completed pre- and post-summer SSSH surveys that included 13 questions on physical, mental, emotional and social health, and fear of falling during daily tasks. Total survey scores could range from 13 to 58 with higher scores indicating better self-perceived health. Participants also completed five pre- and post-intervention functional assessments. The 30 second-sit-to-stand (30STS) is the number of full chair stands or repetitions completed in 30 seconds. The eight ft timed-up-and-go (TUG) is the time it takes to rise from a chair, walk around a marker eight feet away and return to the seated position. Both of these validated tasks are measures of leg strength, balance, and coordination and have strong predictive capabilities for fall risk in older adults (Rose et al., 2002). Historically, static balance tests were used as a proxy for fall risk (Dominguez, 2020) but recently dual task balance tests have been shown to be stronger predictors of fall risk (Commandeur et al., 2018). The short-form Berg balance assessment (SF-Berg) includes seven balance tasks that vary in difficulty. In order they include (1) reaching forward with

an outstretched arm, (2) standing with eyes closed, (3) standing with one foot in front, (4) turning to look back, (5) retrieving an object from the floor, (6) standing on one foot, and (7) sitting to standing. Scores from 22 to 28 indicate healthy functioning, scores from 14 to 21 indicate increased risk for falls, and scores below 14 indicate high risk for falls (Chou et al., 2006). Lastly, upper and lower body flexibility was assessed using the back scratch and seated sit and reach (SnR) tests.

Statistical Analysis

All statistical procedures were performed using IBM SPSS (v26, Armonk, New York) and significance was set at $\alpha=0.05$. All data were reported as unadjusted means and standard deviations (*SD*) in tables or unadjusted means and standard errors (*SE*) in figures. All baseline performance measures were compared using independent *t*-tests. Additionally, independent and paired *t*-tests were used to measure baseline differences between total survey scores and improvements in survey scores within groups, respectively. Lastly, 2×3 repeated measures ANOVAs (RMANOVA) were used to analyze potential group \times time interactions with groups being Repeaters versus Summer Only and times being pre-summer, post-summer, and post-spring. Significant interaction models were further decomposed using paired *t*-tests for within group or independent *t*-tests for between group comparisons.

Results

Both groups were over 90% female and the self-reported racial diversity mimicked that of the recruitment county with 84% White/Caucasian, 8% Asian, 4% Hispanic, and 4% Native American. Over 35% of participants reported taking medication for their blood pressure, this incidence was not different between groups. All but seven participants noted some form of orthopedic ailment, the most commonly cited issues were back and knee pain due to past injury or osteoarthritis. At baseline there was no difference between groups for age, total survey scores, or any of the five functional capacity measures (all $p > .07$; Table 1). Summer Only and Repeater participants reported 1+ and 4+ point improvements, respectively, in their total health survey scores from pre- to post-summer ($p < .05$). Significant time effects were found for 30STS, TUG, and SnR as all scores improved across the first 8-week summer session and these improvements were maintained 10 months later at post-spring (all post hoc $p \leq .01$; Figures 1 and 2). SF-Berg scores and back scratch distance did not change between groups or at any time point (all $p \geq .15$; Figures 1 and 2). After the final spring survey 85% of Repeaters noted improved sleep and 61% reported reduced joint pain. Additionally, 61% of Repeaters reported adding new forms of physical activity to their

Table 1. Baseline Characteristics, Survey, and Functional Performance scores—Mean (SD).

Measures	Repeaters (n= 15)	Summer only (n= 12)	Ind. t-test p Value
Age (years)	61.0 (3.7)	60.4 (6.0)	.781
Health survey scores	48.7 (6.8)	50.1 (4.0)	.412
30STS (reps)	14.1 (5.1)	16.3 (3.8)	.231
8ft TUG (sec)	6.2 (1.7)	5.9 (1.1)	.327
SF-Berg	26.2 (1.7)	27.2 (1.1)	.074
SnR (in)	1.6 (3.7)	2.5 (2.6)	.524
Back scratch (in)	-3.6 (4.5)	-5.8 (4.8)	.255

Ind=independent t-tests; 30STS=30second sit to stand; TUG: timed up and go; SF-Berg=short-form Berg balance tests; SnR=sit and reach.

weekly regimen and 54% noted purchasing personal weights to continue the SSSH program at home.

Discussion

This study demonstrates that participation in a single 8-week SSSH RT program can provide significant improvements to muscle strength and flexibility tasks and participants’ fear of falling and perceptions of their health. These factors are strongly associated with fall risk and independence, suggesting even acute participation in SSSH may reduce fall risk. Furthermore, these data suggest that 8 weeks of participation in SSSH provides benefits to functional performance that may last up to 12 months despite no further participation in the program.

Participation in the 8-week summer SSSH program improved dynamic movement tasks and lower body flexibility that are associated with falls and these improvements were maintained 10 months later. Comparing 30STS data from this study to the CDC’s STEADI initiative (Stopping Elderly Accidences, Deaths and Injuries) (Center for Disease Control and Prevention [CDC], 2018) normative values showed both groups at or above average scores at baseline and for the duration of the study. For the TUG both Repeaters and Summer Only started at and remained nearly 2 seconds below the “at risk for falls” level of 8.5 seconds as discussed by Rose, Jones, and Lucchese (Rose et al., 2002). All pre and post summer short-form Berg scores were within healthy functioning levels, suggesting low fall risk. Lastly, SnR scores were slightly below average at baseline (Chen et al., 2009) but had reached normal values after just 8 weeks of SSSH and remained elevated 10 months later. These data suggest the Summer Only participants started the program with average to above average fitness levels. Furthermore, despite the modeled 2.3% decline, the gains experienced from the first 8 weeks of SSSH were maintained 10 months later in this group. The Repeaters started the program with

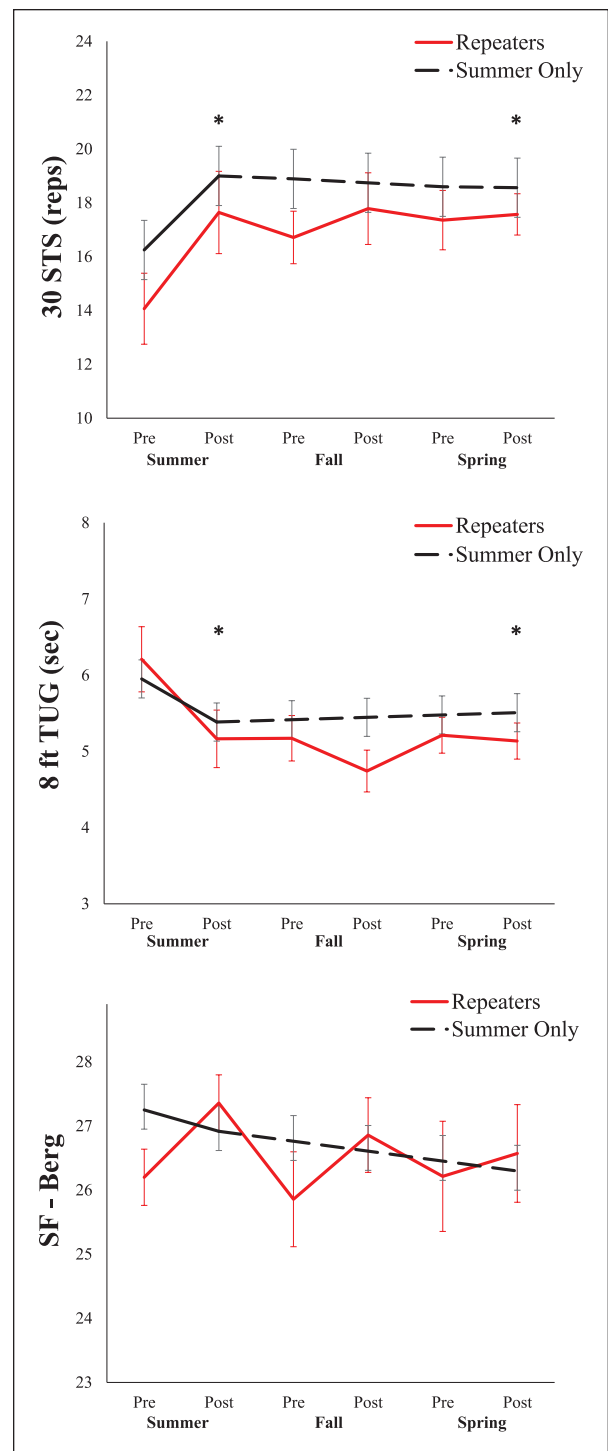


Figure 1. Significant time effects for 30STS (top) and 8ft TUG (center) as functional performance improvements from Pre- to Post-Summer were maintained at the Post-Spring time point (*p < .05). No significant changes across time or group were observed for the SF- Berg (bottom).

average fitness levels that were below Summer Only participants in nearly all measures. However, with sustained SSSH participation, this group’s fitness improved to the level of Summer Only participants and stayed at or above average for age-group normative values. These

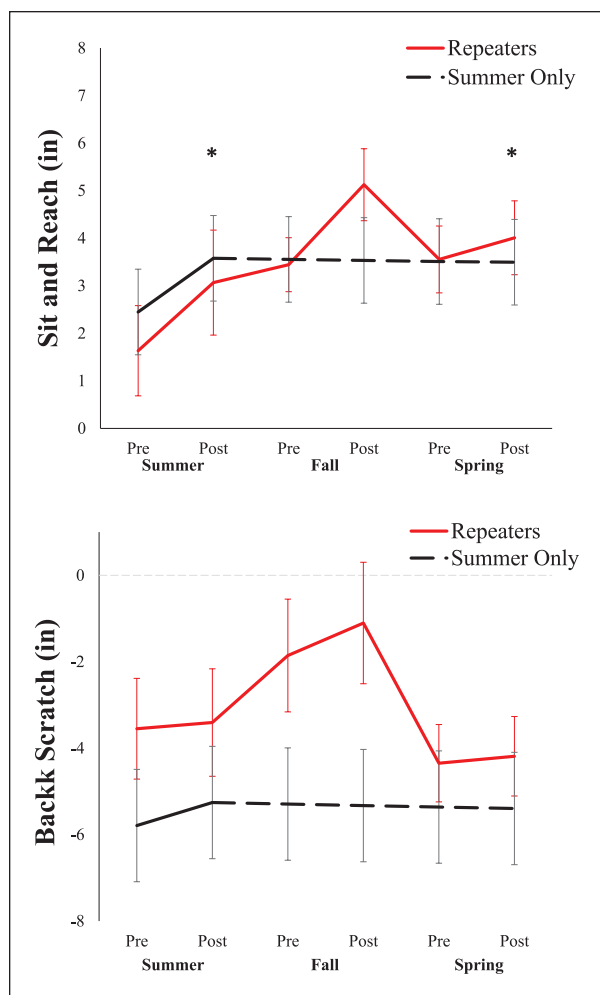


Figure 2. Significant time effect for SnR (top) distance improved from Pre- to Post-Summer and was maintained at the Post-Spring time point ($*p < .05$). No significant changes across time or group were observed for the back scratch distance (bottom).

data suggest SSSH participation effectively improves dynamic task and lower body flexibility performance that can positively affect participants' classifications for fall risk.

Older adults' motivation to engage in RT, and exercise in general, is an important factor to consider. First, despite groups being statistically equivalent at baseline, the Summer Only group started with greater measured and self-perceived baseline health and fitness levels. Summer Only participants may not have recognized a need for improving their health as described by the Protection-Motivation Theory (Rogers, 1975). This could have reduced their motivation for continued engagement as evidenced by a modest 1.1 unit improvement in survey scores while Repeaters reported a large increase of 4.2 units after 8 weeks. Second, many older adults may perceive RT to be difficult and not worth the time. Practitioners need to educate older adults on these data demonstrating acute participation in SSSH can elicit lasting benefits and can kick-start engagement in

other forms of exercise (Baker et al., 2020), which may provide additional motivation to improve health. Data from this study support these findings as over half of Repeaters reported engaging in new forms of physical activity and purchased weights for continued at-home resistance training. Finally, this study showed potential seasonal variations in the amount of decline between SSSH programs. For instance, during the winter months flexibility seemed to decline rapidly while dynamic performance was affected to a lesser extent. Our future endeavors will continue to investigate if seasonal variation may impact the persistence of benefit from RT in the SSSH program.

There are important limitations of this study that can inform future research endeavors. First, the study population is mainly comprised of White/Caucasian females reducing generalizability of the results. Subsequent studies should utilize targeted recruitment strategies to increase diversity beyond that of local demographics. Second, metrics of fall risk commonly used such as the 30STS, TUG, and Short-Form Berg scores stratify participants into fall risk categories, but no such test is a substitute for quality, longitudinal, assessments of falls (incidence, type, location, and injury status). Our program now includes a more comprehensive falls assessment and collects these data at 3, 6, 9, and 12 months following SSSH program participation, regardless of if the participant continues in the program or not.

Conclusions

The SSSH program provides significant benefits to middle-aged adults' lower body strength and flexibility that may be maintained for up to 12 months despite only 8 weeks of participation.

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Declaration of Conflicting Interests

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ORCID iDs

Breanne S. Baker  <https://orcid.org/0000-0002-0098-149X>
Kelsey J. Weitzel  <https://orcid.org/0000-0003-3608-6996>

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