The Influence of Strength-Training Exercises on the Functional Fitness in Older Adults

Susie Engle
University of Arkansas, Fayetteville

Follow this and additional works at: http://scholarworks.uark.edu/etd

Part of the Community Health and Preventive Medicine Commons, Exercise Science Commons, Gerontology Commons, and the Physical Therapy Commons

Recommended Citation
Engle, Susie, "The Influence of Strength-Training Exercises on the Functional Fitness in Older Adults" (2016). Theses and Dissertations. 1682.
http://scholarworks.uark.edu/etd/1682

This Thesis is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of ScholarWorks@UARK. For more information, please contact scholar@uark.edu, ccmiddle@uark.edu.
The Influence of Strength-Training Exercises on the Functional Fitness in Older Adults

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Human Environmental Sciences

by

Susie Jean Engle
Texas A&M University
Bachelor of Science in Psychology, 1991

August 2016
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

__________________________
Dr. Betsy Garrison
Thesis Director

__________________________
Dr. Timothy Killian
Committee Member

__________________________
Dr. Lisa Washburn
Committee Member

__________________________
Dr. LaVona Traywick
Committee Member
Abstract

The purpose of this study was to examine the influence of strength-training exercises on the functional fitness in older adults. The original convenience sample consisted of 658 participants who attended group strength-training classes offered through the Cooperative Extension Service. The Senior Fitness Test was used to assess baseline fitness levels at the beginning and end of the 12-week strength-training program. Data was collected from 2008 to 2015. Of the 658 participants, 110 were aged 60 to 94 and presented posttest scores occurring approximately 12 weeks after pretest dates. Of the 110 subjects, 99 were female and 11 were male. The findings from this study were consistent with prior literature that showed strength-training programs significantly improved functional fitness in older adults. The outcome of this research may assist senior fitness practitioners and policy makers as they seek to improve the quality of life for older adults in Arkansas.
Acknowledgments

Completion of this thesis was only possible with the assistance, guidance, and mentorship of my thesis director, Dr. Betsy Garrison. She took me under her wing and opened my mind to a new way of perceiving research. Her constant support and encouragement helped instill the confidence needed to complete the task. I also extend heartfelt thanks to my committee members, Dr. Timothy Killian, Dr. LaVona Traywick, and Dr. Lisa Washburn. Their insightful feedback and constructive critiques provided a foundation from which I could fly. I am especially grateful to Dr. Traywick and Dr. Washburn for allowing me to use their data for my thesis. Without their generous permission, this thesis would not exist.

Lastly, a special Thank You goes to Dr. Don Bobbitt who reignited my love for learning. His thoughtful yet challenging teaching style in my 2007 Chemistry class motivated me to reach for new heights during a difficult time in my life. For this I will always be grateful.
Dedication

This thesis is dedicated to my family whose constant support, understanding and encouragement allowed me to accomplish this goal. Special appreciation is extended to my father, Roy Swanson; my sisters, Kathy and Linda Swanson; my mother-in-law and father-in-law, Katie and Joe Engle; and especially to my mother, Teresa Swanson, who left this world way too soon. This thesis is also dedicated to all of my friends who provided much needed laughter when my brain was overloaded with thoughts, ideas, and numbers. Most importantly, I dedicate this work to my husband Sean Engle. He was a listening ear for new ideas; my personal chef when I had to keep writing; the most patient and encouraging cheerleader anyone could imagine; and truly my best friend.
Table of Contents

I. Introduction .......................................................................................................................... 1

II. Literature Review ............................................................................................................. 6

III. Methods .......................................................................................................................... 19

IV. Findings .......................................................................................................................... 24

V. Discussion ......................................................................................................................... 27

VI. Reference List ................................................................................................................ 34

VII. Tables .............................................................................................................................. 39

VIII. Appendix .......................................................................................................................... 47
List of Tables

Table 1. Mean ± standard deviation values and SFT-defined range and standards for the 60 to 64 age group..........................................................39

Table 2. Mean ± standard deviation values and SFT-defined range and standards for the 65 to 69 age group..........................................................40

Table 3. Mean ± standard deviation values and SFT-defined range and standards for the 70 to 74 age group..........................................................41

Table 4. Mean ± standard deviation values and SFT-defined range and standards for the 75 to 79 age group..........................................................42

Table 5. Mean ± standard deviation values and SFT-defined range and standards for the 80 to 84 age group..........................................................43

Table 6. Mean ± standard deviation values and SFT-defined range and standards for the 85 to 89 age group..........................................................44

Table 7. Mean ± standard deviation values and SFT-defined range and standards for the 90 to 94 age group..........................................................45

Table 8. Means, standard deviations, t-scores and p-values from paired samples test.........................................................................................46
CHAPTER I
Introduction

Background

Staying physically active throughout life is important for maintaining health, especially as we age (Healthy People 2010). “Scientific evidence suggests that people who exercise regularly not only live longer, they live better” (National Institute on Aging, 2010, p. 15). In fact, staying physically active can help adults to stay independent as they age and continue doing the things they enjoy (NIA, 2010). The U.S. Census Bureau calculated that adults aged 65 and older accounted for 13% of the 2010 U.S. population, and a slightly higher percent of those adults lived in Arkansas. It is expected that these numbers will continue to rise because the senior adult group is growing faster than all other age groups in Arkansas (Arkansas Department of Health, 2013). With this projected uptick, it will be imperative to preserve and improve the health of older adults so they can remain independent for as long as possible (Rikli & Jones, 2013). This is especially important because 29% of senior Arkansans were classified as obese in 2016 according to the United Health Foundation. Furthermore, Arkansas ranked 36 out of 50 states; with the best score held by Hawaii at 14% elderly obese and Ohio in the 50th rank with 33% (United Health Foundation, 2016).

When older adults maintain independence through physical health, they are better able to performing necessary activities of daily living (ADLs) and improve physical function (Sardinha et al., 2015). Alternatively, as physiological function is lost, fall injuries are more common and health care costs increase. Nearly 32% of US adults aged 65 and older had fallen and sustained an injury in 2010 (Centers for Disease Control and Prevention, 2010). Fall injuries required the hospitalization of 700,000 patients each year (CDC, 2016) and direct medical costs for falls in
2013 totaled $34 billion. Both the cost to treat fall injuries and the number of falls are expected to increase because the US population is aging (CDC, 2016).

Research shows that older adults who stay physically active have a reduced risk for falls (DiBrezzo et al., 2005) and exercise can also maintain and improve the ability to perform ADLs (Santana-Sosa et al., 2008). Because impaired mobility has been associated with severe health issues like depression, cancer, and injuries secondary to falls, these illnesses can lead to increased risk of death (Satariano et al., 2012). The Centers for Disease Control and Prevention recommends adults aged 60 and older should exercise 30 minutes each day (Healthy People 2010). In addition, the US Department of Health and Human Services suggests a minimum of two days each week for strength-training (2015).

Advancing years have traditionally been considered as a period of disease onset and loss of function (Santos et al., 2012). Maintaining functional fitness is important because it is essential to performing instrumental ADLs such as shopping, cooking, and cleaning (Rikli & Jones, 2001) as well as basic ADLs like feeding oneself, personal hygiene, and mobility (CDC, 2013). In 2012, the US Administration on Aging used limitations in basic ADLs and instrumental ADLs to measure disability. They found that 12% of community Medicare beneficiaries age 65+ reported difficulty in performing one or more instrumental ADLs and an additional 33% reported difficulty with one or more basic ADLs. In contrast, “96% of institutionalized Medicare beneficiaries had difficulties with one or more basic ADLs and 83% of them had difficulty with three or more basic ADLs” (US Administration on Aging, 2014).

Typically, functional fitness is defined as “having the physiologic capacity to perform normal everyday activities safely and independently without undue fatigue” (Rikli & Jones, 1999, p. 133). Further, the physical parameters of functional fitness are: aerobic endurance,
muscle endurance, muscle strength, agility/dynamic balance, flexibility and body composition (Rikli and Jones, 1999). Because assessing the status of these parameters in older adults would provide valuable information and it had been a challenge to obtain physiological assessment of fitness levels in older adults, the Senior Fitness Test (SFT) was developed to more appropriately assess this population (Rikli & Jones, 1999). The SFT consists of eight test items and has been substantiated by subsequent studies to be highly reliable. These items are:

1. Chair stand for lower body strength – With arms folded across chest, the number of full stands completed in 30 seconds
2. Arm curl for upper body strength – Using a five-pound weight, number of curls in 30 seconds
3. Chair sit-and-reach for lower body flexibility – When seated at edge of chair with leg extended, distance in inches between extended hand and toes
4. Back scratch for upper body flexibility – With one hand reaching over shoulder and second hand reaching up the middle of the back, distance in inches between hands
5. Six-minute walk for aerobic endurance – While walking fast, travel as many yards as possible within six minutes
6. Two-minute step test for an alternate aerobic test – Total number of high steps completed within two minutes
7. Eight-foot up-and-go for motor agility/dynamic balance – Total number of seconds needed to stand up, walk eight feet and return to seated position
8. Height and weight for body mass index (BMI) – Calculated by using the equation

\[ \text{BMI} = \frac{\text{kilograms}}{\text{meters}^2} \]

(Rikli & Jones, 2001)
Since its creation, the SFT has provided researchers with a reliable tool to measure functional fitness and therefore, the effectiveness of physical interventions in older adults (Rikli & Jones, 2001). As each new strength-training intervention is developed for the older adult population, the SFT is used to evaluate program relevance in functional fitness studies. The current study is no exception and seeks to provide additional insight based on SFT participant results.

_Purpose of this study_

The purpose of this study was to examine the influence of strength-training exercises on the functional fitness in older adults as it relates to the performance of instrumental ADLs. If the onset of functional limitations can be postponed or eliminated, this would dramatically reduce consumption of health care resources (Santos et al., 2012). The study adds to the body of knowledge by contributing to the understanding of how strength-training interventions may influence senior adult functional fitness.

_Definitions_

The following definitions were used throughout this study.

- _Senior Fitness Test (SFT):_ a battery of test items that cover the major components of fitness for older adults and measures people aged 60 to 94 and across a wide range of ability levels (Rikli & Jones, 2013).

- _Functional fitness:_ allows independent function and the performance of activities of daily living for oneself without tiring (Rikli & Jones, 1999).

- _Detraining:_ a partial or complete loss of fitness adaptations after cessation of physical training (Dudley & Snyder, 1998).
Older adults/senior adults: people aged 60 and older (Centers for Disease Control website, 2016).

Young-old (YO): adults aged 60-73 year (Toraman, 2005).

Old (O): adults aged 74-86 years (Toraman, 2005).

Delimitations

The population for the sample was limited to those living in Arkansas and may not be generalized to others. The conclusions might not reflect trends found among people from other regions, states or countries.

The geographical location and age of participants were the only known identifying characteristics. Future studies might include the socioeconomic factors of ethnicity, household income, and level of education.

The sample for this study was a convenience sample of those participants who voluntarily engaged in strength-training classes offered by the University of Arkansas Cooperative Extension Service. Because there was no control group, conclusions after the strength-training interventions cannot be as strongly inferred.

Assumptions

There were three assumptions that guided the current study.

1. It was assumed that all participants received SFT evaluations prior to the strength-training intervention.

2. It was assumed that participants regularly attended the strength-training intervention sessions.

3. It was assumed that participants received SFT evaluations at the end of the 12-week strength-training intervention.
CHAPTER II
Literature Review

Functional fitness

Research shows that functional fitness in older adults can be maintained and improved through community-based strength-training programs (Seguin et al., 2012) as well as high-intensity aerobic interval exercise (Brovold et al., 2013). Further, strength-training is as effective as aerobic-based training for improving physical skills that are attributed to functional mobility (Martins et al., 2011). In addition, functional fitness can also be improved by participating in creative dance (Cruz-Ferreira et al., 2015), recreational activities like badminton and croquet (Cho et al., 2014), as well as participation in sport-simulated video games (Maillot et al., 2014) and the practice of Tai Chi (Lin et al., 2015).

Training intervention versus daily physical activity for functional fitness

A wide range of research has been conducted to support the use of exercise training programs for the maintenance of functional fitness in older adults. The data suggests specific interventions like power training are an effective way to improve physical function (Miszko et al., 2003; Bottaro et al., 2007). Further, progressive resistance training effectively preserves independence levels by improving functional performance and ability to perform ADLs (Valenzuela, 2012; Henwood et al., 2008; Glenn et al., 2015). High velocity resistance training was shown to significantly increase physical performance, prolong independence, and improve quality of life (Henwood & Taaffe, 2005).

Although a plethora of research promotes the benefits of programmed training interventions, there are a few studies reporting evidence for the use of normal daily activities to maintain functional fitness. This research found that physical activity (PA) levels are predictive
of physical performance and that older adults with higher PA levels demonstrate better physical function and mobility (Morie et al., 2010). In addition, PA is related to musculoskeletal fitness and higher PA levels are associated with better balance and muscular endurance (Lohne-Seiler et al., 2016). Even though performance on fitness tests correlated to the number of steps taken per day (Yoshida et al., 2010), two separate studies found significance in the number of steps taken. Greater functional fitness was associated with 6500 steps per day (de Melo et al., 2014) and fitness was well maintained for older adults who walked more than 8000 steps per day (Aoyagi et al., 2009).

**Literature review**

A recent search was conducted in the Web of Science and ERIC databases to survey the last 10 years and utilized the phrase “senior fitness test” to identify specific studies referencing the SFT. Additional background citations were located from the reference lists within each article.

Of the 85 total references located, 36 were selected to inform the current analysis because the research specifically used the SFT before and after a strength-training intervention to assess functional fitness. Twenty-nine of these selected articles provided background information and prior references. Seven seminal studies were found to be distinctive in the impact with which they were cited in other articles. Thus, this seminal research influenced and stimulated the writing of other scientific papers and ultimately, the body of knowledge. The similarities and differences in the research are discussed in (a) stated purpose for studies; (b) sample and sampling; (c) methods; (d) program interventions; and (e) program results and implications.
Stated purpose for studies

Although the purpose for each study had a distinct focus, all of the seminal articles shared a commonality to maintain or improve functional fitness/independence in older adults. For example, the intention of one study was to predict the level of capacity required for maintaining physical independence into later life, so the researchers developed and validated criterion-referenced fitness standards for older adults (Rikli & Jones, 2013). In contrast, a second study from Portugal focused on investigating the impact of physical activity and sedentary time on functional fitness. More specifically, this study examined the level of moderate-to-vigorous physical activity as well as the documented sedentary time of independently functioning, community-dwelling older adults (Santos et al., 2012). A third study centered on the functional challenges of Alzheimer's patients. These researchers sought to determine the effects of a 12-week training program on the overall functional capacity of the patients as well as their ability to perform activities of daily living (Santana-Sosa et al., 2008). In stark contrast with the failing health of Alzheimer's patients, the fourth study focused on older male golfers and the effect of a progressive training program on club head speed and functional fitness (Thompson et al., 2007).

Unlike the previously discussed articles, a fifth study highlighted the effects of detraining in older adults. Interestingly, this study from Turkey assessed the effects of short-term and long-term detraining on functional fitness and sought to determine whether any effects differ according to young-old (YO) and old (O) age categories (Toraman, 2005). Following a similar intent, the sixth article (Toraman & Ayceman, 2005) focused solely on the effects of detraining on functional fitness after a six-week timeframe. Although similar, both studies offered different perspectives in regard to timeframes for detraining. As for the last seminal article, the researchers
evaluated an inexpensive exercise program for community-dwelling older adults in order to reduce fall risk by improving strength and dynamic balance (DiBrezzo et al., 2005).

Although each study focused on a specific aspect of functional fitness, the maintenance or improvement of physical independence in older adults was the primary focus. In summary, the researchers sought evidence that fitness programs make a difference.

Sample and sampling

Regarding study samples, the articles provided a range of sizes, participant descriptions, and varied use of control groups. In addition, two of the articles did not utilize control groups in their research. The first of these studies (Santos et al., 2012) selected participants through a proportionate stratified random sampling that included non-institutionalized Portuguese adults as the representative sample. Total participants included 312 (aged 65-103); with 117 males and 195 females. The decision to proceed without a control group might have been related to the study design. For example, a control group may not have been necessary because the research was focused on the relationship between two grouped variables observed in each participant: (a) functional fitness and physical activity; and (b) functional fitness and sedentary time. Subsequent to data collection, association scores for each variable group were created, analyzed, and reported for each participant. The second study (DiBrezzo et al., 2005) recruited a convenience sample of 16 senior adults from two local, rural, senior community centers where the participants regularly attended activities. The participant age range was 60-92 and consisted of thirteen women and three men in varying degrees of health. The lack of control group in this study is clearly stated as a limitation. The researchers further acknowledge that the observed improvements may not be related to exercise program participation.
Of the studies that utilized control groups, all four used a relatively small number of participants. The first study (Santana-Sosa et al., 2008) selected Alzheimer’s patients from a residential nursing home and these participants were assigned to one of two groups using a randomized block, controlled design. The exercise group contained three males and five females aged 72-80 and the control group contained three males and five females aged 69-77. Compared to the Alzheimer’s research, the second study (Thompson et al., 2007) was on the other end of the spectrum of health and focused on healthy older male golfers from a private golf club. The participants aged 60 to 80 were randomly chosen from a convenience sample with 11 assigned to the exercise group and seven to the control group. Each participant chosen was free from metabolic or cardiovascular disease and averaged 40 rounds of golf each year. The third and fourth studies (Toraman, 2005; Toraman & Ayceman, 2005) were the most dissimilar in the group and utilized the same sample subjects for both studies. Participants were volunteers 60 years and older and in good health without serious musculoskeletal or cardiovascular diseases. The YO group (aged 60-73) contained 22 participants with 12 in the exercise group and 10 in the control group. The O group (aged 74-86) consisted of 20 subjects with nine in the exercise group and 11 in the control group.

In contrast with the above-mentioned research, the last study (Rikli & Jones, 2013) used a unique subset of participants from a large sample of previously conducted research. More specifically, the research utilized fitness scores from 2,140 moderate-functioning older adults who were part of 7,183 total participants in the original research from 1999.

Although the studies were markedly different in their sample sizes and control groups as well as participant description, each sought to evaluate their fitness program in a population of
older adults. Functional fitness is important for seniors from all walks of life and these studies contributed new information to assist a broader range of senior adult populations.

Methods

Regarding the methods used for each seminal study, they were largely dissimilar from each other except for the two articles involving Turkish subjects. Although both of these studies included a 9-week multicomponent exercise training program and compared the assessments from both the YO and O participant groups, there were distinct differences with regard to the timing of the SFT assessment. One study (Toraman, 2005) used the SFT at both the six-week and 52 week detraining milestones and the other study utilized the SFT every two weeks during a six-week detraining period (Toraman & Ayceman, 2005). As will be discussed later, both studies yielded intriguing results.

In contrast with the above method, the next study (Rikli & Jones, 2013) identified a criterion measure to assess physical independence and proposed fitness standards associated with having the ability to function independently. The basis for the criterion was derived from longitudinal research on aging and physical capacity together with scores from a large cross-sectional database of moderate-functioning older adults. Similar to this study, the functional fitness of participants in another study (Santos et al., 2012) were assessed using the SFT; however, this Portuguese research also used accelerometers to calculate sedentary behavior as well as the time participants spent performing physical activity.

Like most of the other studies, the article on Alzheimer’s patients (Santana-Sosa et al., 2008) was focused on evaluation of functional fitness and assessed participants both before and after the intervention. Contrary to the other articles, this study centered on the functional capacity of Alzheimer's patients and their ability to perform ADLs as well as gait/balance activities within
a nursing home setting. It is worth noting that all training sessions and evaluations of the participants occurred within the nursing home.

Unlike two of the other seminal studies, the research conducted on club head speed (Thompson et al., 2007) incorporated both an exercise group and a control group. The exercise group participated in an 8-week progressive functional training program, but the control group was directed to continue their normal level of activity during the study. Pre and post assessments of club head speed were taken for both groups; however, the SFT was only administered to the exercise group. The intriguing specifics of the study results will be discussed in a later section.

Although the study on fall risk (DiBrezzo et al., 2005) similarly utilized the SFT to evaluate measures of flexibility, aerobic endurance, functional strength, and dynamic balance and agility, this study also obtained measures of cognitive function, blood lipids, resting blood pressure, weight and height. Further, the study was uniquely different than the others by relating an increased functional fitness level to reduced fall risk.

The methods used in each investigation were more disparate than similar because the researchers instituted specific procedures to conduct their particular study. Even though all seven study methods were not the same, each individual study did seek to assess if physical training programs made a difference in the functional fitness of older adults.

*Program interventions*

There were many similarities among the seminal articles regarding intervention measures. Most notably, five of them incorporated specific exercise training programs that included components for muscle strengthening, balance, flexibility and endurance. Nevertheless, each study did utilize very unique interventions to address the research purpose. For example, the Alzheimer’s patient intervention (Santana-Sosa et al., 2008) included a total of 36 programmed
training sessions consisting of 3 weekly sessions of 75 minutes duration over a 12-week period. Moreover, the exercises were conducted within the nursing home and an exercise scientist supervised each session. Additionally, this study also included exercise components for joint mobility and coordination and was highly structured in its methodical delivery.

Another study (Thompson et al., 2007) that incorporated a progressive functional training program was highly structured as well and consisted of an 8-week format. Notably, the framework for the program's systematic progression of exercises was adapted from the National Academy of Sport Medicine's Optimum Performance Training Model. Like the Alzheimer’s patient study, this program included exercise movements for flexibility, balance and resistance; however, the first portion of the program primarily focused on development of neuromuscular control and enhancement of spinal stabilization.

Similar to the club head speed and Alzheimer patient studies, the intervention for the two Turkish studies (Toraman, 2005; Toraman & Ayceman, 2005) incorporated a multicomponent training program to include activities for aerobic, resistance, and flexibility. All training was supervised by research staff and was specifically adjusted each week. For example, the aerobic training variables were set at a frequency of three days per week, duration of 20 minutes per session, and 50% of heart rate reserve for intensity. It is worth noting that an important part of the intervention was detraining and therefore lack of activity was a key component of the research after the training program was completed.

Like the research above, the next study (DiBrezzo et al., 2005) included exercises focused on balance, strength-training and flexibility; however, this program was specifically designed to be low-cost and was developed based on recommendations from the American Council on Exercise and the National Institute on Aging. The total program lasted 10 weeks and
consisted of three 1-hour classes per week. Similar to the Alzheimer’s patient study, exercise sessions utilized minimal equipment and typically involved dumbbells, elastic bands, or exercise balls. In addition, care was taken to constantly change equipment use on alternating days so variety in the routine was maintained in the upper body and lower extremity activities.

In contrast to the above studies, two articles contained unique features regarding their interventions. The first study (Santos et al., 2012) was unusual in the respect that the intervention was the actual sedentary behavior as well as physical activity performed during the participants' normal daily routine. As measured by accelerometers, the participants were asked to wear the device on four consecutive days, including two weekdays and two weekend days. Since the device measured the acceleration of normal human movements while ignoring the high frequency vibrations from mechanical equipment, the researchers were able to calculate various aspects of physical activity or non-activity. Some of these variables included: vigorous activity, moderate activity, sedentary behavior, and total physical activity intensity.

The second study (Rikli & Jones, 2013) actually did not utilize an intervention, but did use a subset of the normative data from previous SFT research. Therefore, the new criterion-referenced fitness standards were based on previously validated research. More specifically, the research used fitness scores from 2,140 older adults who were part of a 7,183 participant study in the original 1999 research.

To summarize, program interventions ranged from non-activity to specifically designed fitness programs for the chosen population. Program length varied from 8 weeks to 12 months. Even when lack of activity was the variable of interest, the research goal was always to ascertain the influence of physical activity on the functional fitness of senior adults.
Program results and implications

In continuation of the discussion on fitness standards (Rikli & Jones, 2013), it is worth noting that the results and implications from this research were vastly different from other studies in this group. For example, the outcome of the study generated performance standards that indicate the level of fitness associated with late life physical independence for women and men aged 60-94. Most importantly, these performance standards provided a method for assessing older adult capacity that is associated with physical independence. This easy-to-use, clinically relevant standard was unavailable prior to this research and can be utilized to plan programs for targeting areas of weakness and therefore reduce risk for loss of independence and mobility (Rikli & Jones, 2013).

In contrast to the article above, the next study (Santos et al., 2012) generated a different type of result that suggested a multi-faceted approach for improving functional fitness in older adults. Interestingly, the research found that physical activity and sedentary time are independently related to functional fitness. More specifically, study results showed improved functional fitness for older adults who either spent less time in sedentary behaviors or more time performing physical activity. Furthermore, this outcome suggests that promotion of both the increase of PA and/or the reduction of sedentary behaviors may preserve performance of ADLs and functional fitness.

Like the research on sedentary time, the following three studies conveyed results that were similar in their support of using exercise training to improve functional fitness in older adults. For example, one study (Santana-Sosa et al., 2008) showed significant improvements in lower and upper body strength, flexibility, agility, balance, and endurance after exercise training. Since the ability to perform ADLs independently was also seen as a positive outcome, this study
suggested that Alzheimer’s patients might realize benefit from exercise training included as a nursing care protocol.

The second study (Thompson et al., 2007) also realized significant improvements in participant results after a functional training intervention. In comparison with the control group, the exercise group increased their maximal club head speed and also improved in most components of the SFT. The research suggested that future studies should examine the ramifications of functional training on fitness and sport performance in older adults.

The third study (DiBrezzo et al., 2005) reported several health and fitness-related improvements at the conclusion of the exercise training regime. Specifically, the research revealed functional fitness improvements in the areas of agility, dynamic balance, upper extremity flexibility, and upper and lower extremity strength. Of particular interest, statistically significant improvements were recorded on four of the SFT components: 8-foot up-and-go, chair stand, arm curl, and back scratch. Because increased strength and balance can reduce risk of falling (Gregg et al., 2000), the research results indicate that effective physical training programs can improve functional fitness and positively affect factors that reduce falling (DiBrezzo et al., 2005).

Although both Turkish studies (Toraman, 2005; Toraman & Ayceman, 2005) have many similarities to the other seminal articles and do report improved functional fitness upon completion of the exercise training period, these two studies are decidedly different with regard to detraining as the research focus. In particular, the first study (Toraman, 2005) reported that short term (six week) detraining caused some loss of functional performance improvement. More specifically, six-week performance for the YO group remained higher than the O group, and after long term (52 week) detraining, performance for both groups returned to the pre-training
assessment or lower. Interestingly, scores for the O group were consistently lower than before training. As for implications, the factor most affected by short term detraining was agility, but long term detraining affected aerobic endurance as well as upper extremity strength. Further, the results showed that changes in functional capacity after both short term and long term detraining were influenced by age of the individuals (Toraman, 2005). Regarding the second study (Toraman & Ayceman, 2005), the focus was on participant scores during six weeks of detraining. At the two week mark, the YO group did not exhibit significant changes from post-training values; however, the O group significantly declined in performance on the chair stand and six minute walk. At four weeks, SFT values further declined in both groups with significant performance losses reported for the YO group in the six minute walk, chair sit and reach, and chair stand. After six weeks of detraining, the O group further declined in the chair stand and up-and-go test. As for implications, lower extremity flexibility was the component most affected by detraining at two and four weeks, with agility and balance affected after six weeks (Toraman & Ayceman, 2005).

With regard to results and implications, each study provided very specific outcomes based on the intended research focus. Even though the study conclusion may have been a new set of performance standards or the impact of detraining, all the articles provided evidence for the influence of physical activity on functional performance.

In summary, these seven foundational articles revealed some similarities and identified notable differences with regard to population, purpose, interventions, methods and implications. Because the studies utilized the SFT and were highly cited in other research, they provided unique and valuable insight into the affect of training interventions on senior adult functional
fitness. Based on the previous research, and after controlling for age, gender and geographic location, functional fitness is expected to increase subsequent to participant engagement in strength-training programs.
CHAPTER III
Methods

Hypothesis

In general, strength-training exercises influence functional fitness improvements in older adults. More specifically, performance scores on six distinct measures are associated with maintaining functional mobility and physical independence: chair stand, arm curl, 2-minute step, chair sit-and-reach, back scratch, and the 8-foot up-and-go.

Participants and data collection

The convenience sample consisted of 658 subjects who participated in group strength-training classes offered through the Cooperative Extension Service. The participants were from 22 counties in Arkansas with ages ranging from 23 to 94 years old. To assess a baseline fitness level, the first SFT date for each participant was at or near the beginning of the strength-training program. Subsequent SFT testing typically occurred at 12 weeks after the start of the program and at least twice each year thereafter. County Extension agents and strength-training program volunteer leaders collected data from 2008 to 2015. Of the 658 participants, 166 presented posttest scores occurring 10 to 14 weeks after pretest dates. Because the SFT is specific to adults aged 60 to 94, 110 of the 166 participants fit this criteria and were eligible for inclusion in the analysis. The Institutional Review Board of the University of Arkansas, Fayetteville, approved the procedures used in this study.

Senior Fitness Test measures

As mentioned earlier, evaluation and management of physical decline in older adults was limited prior to 1999 by the lack of appropriate measurement instruments (Rikli & Jones, 1999). The SFT was created to resolve this issue and each test item “was selected because of its ability
to reflect (in a reliable and valid way) one of the physical parameters of functional fitness” (Rikli & Jones, 1999, p. 135). More specifically, the test items and their associated purpose include: 30-s chair stand for lower body strength, arm curl for upper body strength, chair sit-and-reach for lower body flexibility, back scratch for upper body flexibility, 6-min walk for aerobic endurance, 2-min step test as an alternate aerobic test, 8-ft up-and-go for motor agility/dynamic balance, height and weight for body mass index (Rikli & Jones, 1999). More details for SFT criterion fitness standards as well as the normal range of scores for women and men by age group are found in Tables 1 through 7.

Senior Fitness Test protocol

To ensure accurate measures, testing efficiency, and participant safety, several conditions and pretesting procedures were addressed (Rikli & Jones, 2013).

1. Technician training – County Extension agents and volunteers were properly trained regarding testing procedures. All staff were instructed to follow the exact protocols for conducting the tests and recording scores.

2. Waiver of liability and informed consent – To ensure participants were well informed of the purpose and risks of the test, County Extension agents and volunteers obtained a signed informed consent and waiver of liability form from each participant. This form was received prior to enrollment and covered participation in group classes and fitness testing.

3. Participant screening – Although most community-dwelling older adults could safely participate in the SFT without medical screening, County Extension agents and volunteers were mindful to watch for participants with uncontrolled high blood
pressure, congestive heart failure, or any other medical condition that prohibited exercise activity.

4. Communication of pretest instructions – Participants were prepared for test day and received instructions to avoid excess alcohol use 24 hours before testing as well as strenuous physical activity a day before testing; to eat a light meal one hour before testing; and wear appropriate clothing.

5. Aerobic preparation – Participants were instructed to practice the aerobic endurance test before actual test day so they could make knowledgeable decisions about personal pace and effort.

6. Testing supplies and equipment – Prior to test day, State program coordinators provided at least one portable fitness assessment kit containing all needed supplies and equipment to each county.

7. Data scorecards – Test score reporting forms were prepared before testing and County Extension agents and volunteers were instructed to make a note on the form of any deviations from proper protocol.

8. Order of testing – Each testing site had the option to administer the SFT in one of two ways depending on what was most convenient for their population. Tests could be conducted during individual appointments or testing stations may have been used for large groups with one or two tests per station. Participants were instructed to go to stations with openings until their scorecard was complete. If conducted in a group setting on class day, the County Extension agents had the option to conduct the SFT before the exercise session, during the exercise session, or instead of the exercise session. The 2-minute step test was used as the aerobic endurance measure for all
locations and the remaining six tests could be conducted in any order: chair stand, arm curl, chair sit-and-reach, back scratch, 8-foot up-and-go and height/weight measurements.

9. Environmental conditions – County Extension agents and volunteers were mindful of participant overheating and overexertion and conducted the testing when temperature and humidity conditions were at comfortable levels.

10. Symptoms of overexertion – County Extension agents and volunteers were instructed to stop testing immediately if the following conditions were observed: blurred vision, confusion, nausea, numbness, pain, irregular heartbeat, tightness in chest, dizziness, shortness of breath.

**Test administration**

County Extension agents and volunteers led participants through appropriate warm-up and stretching activities for five to eight minutes prior to testing. Warm-up activities were not strenuous and involved exercises for large-muscle groups. Simple stretches followed the warm-up and included focus on muscles to be stretched during the test like hamstrings and shoulders. Participants were encouraged to do their best, but to stay within their own safety limits and to refrain from overexerting. Procedures for these seven SFT items were followed as outlined in the SFT Manual: chair stand, arm curl, 2-minute step, chair sit-and-reach, back scratch, 8-foot up-and-go and height/weight measurements (Rikli & Jones, 2013). As previously noted, improvement for all but one of the SFT measures is represented by an increased value, for example, an increased step count over a 2-minute timeframe. In contrast, improvement is realized for the 8-foot up-and-go when a decrease in value is recorded denoting a faster speed (Seguin et al., 2012).
**Intervention**

Developed by Tufts University researchers and created for women in midlife and older, the StrongWomen program was the evidence-based strength-training program used as the intervention for this study. The intervention was delivered as a series of strength-training classes that occurred twice weekly. Trained County Extension agents and volunteer leaders instructed participants during regular one-hour strength-training classes over 12 weeks. Sessions typically included a warm-up, eight to ten strengthening exercises, and cool-down with stretching. Because the intervention was community-based, classes usually met in churches and community centers as well as in meeting rooms within county Extension offices (Washburn et al., 2014).

**Data Analysis**

SPSS was used to analyze the data. Following frequency analysis, a paired t-test analysis was performed to determine pretest to posttest differences in SFT variables so the hypothesis could be tested. Because an effect was expected in one direction, test results were reported as one-tailed. Six SFT test items were analyzed: chair stand, arm curl, 2-minute step, chair sit & reach, back scratch, and 8-foot up-and-go.
CHAPTER IV
Findings

Fitness of sample

Mean and standard deviation values are provided for both pretest and posttest scores and the tables present separate test results for females and males. For ease of reference, the SFT-defined normal ranges and criterion fitness standards appear for each age group and gender. A brief highlight for the age groups can be found below each table.

Detailed description for fitness of sample

The fitness of this sample is described using the pretest scores, the posttest scores, and the changes that occurred pre to post. The pretest scores are examined to assess the level of fitness before participants began the strength-training program. The posttest scores are used to reflect their level of fitness after the strength-training program, and the changes that occurred between the pretest and posttest dates are described.

Each age group exhibited different fitness levels throughout testing (Tables 1 through 7). The 60 to 64 year old females scored out of normal range on the back scratch pretest only, but achieved normal range scores on the back scratch posttest (Table 1). Interestingly, the 65 to 69 year old females were only out of normal range on the 2-minute step, but reached normal scores for their 2-minute step posttest (Table 2). When comparing the males in these two age groups, the sole 60 to 64 year old male scored below normal range on all tests except the arm curl (Table 1) while the two 65 to 69 year old males scored at or above normal range for all six tests (Table 2).

The 70 to 74 year old females may be in the best functional shape of the sample with scores at or above normal range for all pretests and posttests (Table 3). Likewise, the lone male
in this same age group exceeded the criterion fitness standards on three of the four tests (Table 3). Age group results for 75 to 79 year olds indicate that females were able to reach normal range scores after the strength-training intervention while the four males met or exceeded normal range with posttest scores in all but the chair sit & reach (Table 4).

Similar to the 65 to 69 year old females, the women aged 80 to 84 also scored within or above normal range for all tests except the 2-minute step (Table 5). Further, the posttest scores for 80 to 84 year olds also exceeded the criterion fitness standards for three of the four tests. For the 85 to 89 year olds, an unexpected result was noted. Both pretest and posttest scores for women and men fell below normal range on a majority of the test items (Table 6).

The last age group consists of only two females and one male aged 90 to 94 (Table 7). Posttest scores for the females showed improvement in five of the six tests and the sole male improved in five tests as well. Interestingly, the 90 to 94 year olds appear to be in better functional shape than the younger 85 to 90 year old group.

In summary, posttest scores conveyed general improvement of functional fitness for both women and men. The means reported for all seven age groups indicate a slight overall decline in scores across all tests with increasing age.

**Statistical Analysis**

Based on analysis, functional fitness improvements were observed at the end of the 12-week strength-training intervention. The mean age of participants was 71.12 ± 7.7 years. Statistically significant improvement was observed for the chair stand (t = 10.41, p = .000). Performance increase in the arm curl test (t = 7.90, p = .000) was also shown to be significant. Progress in the 2-minute step (t = 9.87, p = .000) proved significant as well. Significant improvements were reported for the chair sit & reach (t = 6.04, p = .000).
(t = 1.73, p = .043) conveyed significant change. Significant fitness improvements were also realized in the 8-foot up-and-go (t = 6.12, p = .000). Thus, supporting the hypothesis that strength-training exercises influence fitness improvements in older adults (Table 8).
CHAPTER V
Discussion

The purpose of this study was to examine the influence of strength-training exercises on the functional fitness in older adults. The 12-week intervention did influence functional performance of the senior adults in this study. The strength-training program improved performance for flexibility, strength, endurance, and balance.

Regarding flexibility, the two test items associated with this measure are the chair sit-and-reach and the back scratch. Achievement of normal range scores for both tests required pliable muscles as well as good range of motion. Improvements observed for the chair sit-and-reach might reflect the use of the specific stretching exercises included in the intervention in addition to the warm-up and stretching provided immediately prior to testing. The preparation exercises for the chair sit-and-reach may have included a seated or standing hamstring stretch at the end of each exercise class (Nelson & Seguin, 2003). The flexibility gains observed in this study are similar to the seminal article (Thompson et al., 2007) that focused on club head speed in older golfers. In that study, chair sit-and-reach scores were also significantly improved after specific intervention.

In the back scratch test, participants attempted to increase their range of motion while reaching one hand over their shoulder and their other hand up the middle of the back. Fitness advances were realized as fingers moved closer to each other. Significant improvements in the back stretch test scores might be a result of stretching techniques used during the exercise program as well as on test day. These findings are similar to the study on fall risk (DiBrezzo et al., 2005), where significant improvements were also reported for the back scratch after a
strength-training intervention. Two stretching exercises that might have contributed to the outcome could be the single-arm cross over and the chest stretch (Rikli & Jones, 2013).

The two test items related to muscle strength are the chair stand for lower body strength and the arm curl for upper body strength. Achievement of normal range scores for both tests required muscular strength and quick repetition. Fitness improvements noted for the chair stand could be associated with the specific leg strengthening exercises incorporated in the intervention. Some of these exercises may have included weighted and non-weighted squats and knee extensions (Nelson & Seguin, 2003). Like the current study, both seminal articles conducted in Turkey (Toraman, 2005; Toraman & Ayceman, 2005) also reported significant improvements in the chair stand scores after participants completed a strength-training program.

In the arm curl test, participants attempted to curl a dumbbell (5 lbs. for women and 8 lbs. for men) as many times as they could in 30 seconds. This assessment of upper body strength provides a good gauge of muscular strength for senior fitness practitioners. Improvement in fitness was achieved when the participant reached normal range scores for their age group. Some of the intervention exercises that may have contributed to participant improvement could include the bicep curl and the upright row (Nelson & Seguin, 2003). It is worth noting that the seminal study which focused on Alzheimer’s patients (Santana-Sosa et al., 2008) also observed a significant increase in arm curl performance after an exercise training intervention. Further, the research showed an improved ability to perform ADLs and a potential reduced risk for falls.

The 2-minute step is the test item associated with aerobic endurance. The participants were required to step in place while assuring both knees reached the correct height. The participants attempted to step as many times as they could in a 2-minute period (Rikli & Jones, 2013). Improvements in the 2-minute step scores might have been a result of aerobic activities
incorporated during the exercise program. This assumption is strongly supported by the study researching physical activity and sedentary behavior (Santos et al., 2012) where physical activity was found to be positively associated with aerobic endurance. Two aerobic exercises that may have helped participants improve their scores could include step-ups and walking for time (Nelson & Seguin, 2003).

The test item related to dynamic balance is the 8-foot-up-and-go. Participants were required to stand from a seated position and walk as quickly as possible to a cone 8 feet away. They were instructed to return and sit down in the chair before the time clock was stopped (Rikli & Jones, 2013). This test measured both agility and dynamic balance and was the only test item that required a decrease in score to show improvement. Observed improvements in this measure may have been due to the exercise intervention protocol. Two such activities that might have assisted with the fitness increase could include toe stands and abdominal curls (Nelson & Seguin, 2003).

Like the seven seminal articles, the findings of this study support the use of strength-training interventions as an effective way to improve functional fitness for this population. The performance outcomes were similar to results of some previous research. For example, one study showed that participation in an exercise program elicited a number of favorable health responses that might play a role in reducing functional decline (Lobo et al., 2011). Another study found that exercise programming improved functional fitness in community-dwelling elderly females and that institutionalized older females declined in functional fitness due to lack of activity (Furtado et al., 2015). Although previous research does support the use of strength training to improve functional fitness in seniors, the current study adds knowledge to the field of
community-based exercise programs. More specifically, significant improvements were realized for all SFT items using the StrongWomen program.

Observed improvements for all functional parameters in this study were likely the result of the specific StrongWomen exercise protocol that focused on upper and lower body strength, flexibility, endurance, and balance. When training is targeted for specific physical function, research has shown positive outcomes (Seguin et al., 2008). For example, other evidence-based exercise programs targeting endurance, strength, posture, balance, and flexibility have also demonstrated improvements after implementation (Moore-Harrison et al., 2009). Further, performance of basic and instrumental ADLs showed significant improvement after participation in novel ADL-based training (Dobek et al., 2006).

Implications

The statistically significant improvements observed in the current study have practical importance for senior adults as well as senior fitness practitioners who desire to help older adults maintain mobility and independence. Although the results of this study suggest that strength-training programs are effective for improving functional performance in older adults, more research is warranted. Similar previous studies have shown that community-based exercise programs helped senior adults improve their functional fitness (Chaudhary et al., 2015). Moreover, multicomponent exercises were helpful in reducing fall risk as well as incident of falls in older adults (Gillespie et al., 2012). It is recommended that future research focus more on how this type of strength-training program may reduce risk for falling. Healthcare and senior health policy makers should also be an integral part of this process so society can realize the physical, emotional, and economical benefits. Because decreases in physical fitness are associated with
higher fall risk in older adults (Toraman & Yildirim, 2010), additional research could provide guidance on how to specifically implement strength-training interventions for this purpose.

Future studies should also research the efficacy of using strength-training programs with various older populations. Positive outcomes have been reported for community-based sedentary seniors after participation in a multicomponent program (Toto et al., 2012), so it would be important for research to include active as well as sedentary community-dwelling individuals from all socioeconomic backgrounds. In addition, improved outcomes were realized for patients with Parkinson’s disease after aerobic and strength training (Carvalho et al., 2015), so future research could also focus on institutionalized seniors in various states of physical and mental decline.

Continued research should also place additional emphasis on the differences between young-old and old age groups and how they specifically respond to functional training. Early research shows that the physical parameters of functional fitness are minimally affected by short term detraining, but longer term detraining can cause a dramatic decrease in all fitness parameters. Research in this area may provide support and motivation for senior fitness practitioners as they encourage their clients to continue exercise participation (Toraman, 2005).

Regular physical activity as well as the reduction of sedentary behaviors can help preserve functional capacity in older adults (Maslow et al., 2011). Because fitness initiatives and programs that enhance senior performance could provide much needed support to senior health professionals, special efforts should be made to provide more opportunities for activity. One way to do this is by providing appropriate access in the communities where older adults live. This access may take the form of well-lit and maintained walking and biking trails. For example, where walking trails already exist, city planners could install additional benches along the route
so seniors may be more likely to walk if they could rely on places to rest along the way. Another opportunity for activity may be community-organized events where groups of individuals walk together and form social bonds that enhance the experience and promote program adherence.

According to the U.S. Surgeon General’s ‘Step It Up!’ Call to Action, the efforts of local government could facilitate lasting health effects by recognizing the importance of physical activity and taking steps to support city walkability (2016). City governments should be encouraged to promote community and street design policies that enhance walking and physical activity. Program and policy strategies are recommended to increase physical activity, including walking and social support interventions. Another way for cities to increase physical activity is through community-wide campaigns, media coverage, education, and environmental changes (Surgeon General, 2016).

Limitations

Although the study results showed significant functional fitness improvements for this population, there are limitations that should be acknowledged. This study did not specifically evaluate the effect of the exercise program for fall prevention even though weakness in the areas of flexibility, balance, and muscle strength are known risk factors for falling. Future research should include fall prevention and risk assessments in order to determine the specific effectiveness of this exercise program for fall risk.

The population for the sample was limited to those living in Arkansas and may not be generalized to others. The conclusions might not reflect trends found among people from other regions, states or countries. Future research could include individuals living in other regions, states and countries so a broader understanding of how this type of intervention may influence those populations.
The geographical location and age of participants were the only known identifying characteristics. Future studies might include the socioeconomic factors of ethnicity, household income, and level of education. This addition may provide a unique opportunity for facilitating new avenues of public health messages and programs.

The sample for this study was a convenience sample of those participants who voluntarily engaged in strength-training classes offered by the University of Arkansas Cooperative Extension Service. Because there was no control group, improvements after the strength-training interventions cannot be as strongly inferred. Future studies could include control groups and may further strengthen the current research outcomes.

The number of males in this study was limited when compared to the number of females. Future research should include a larger male sample so the influence of strength training on functional fitness in men can be more thoroughly understood.

Conclusion

The purpose of this study was to examine the influence of strength-training exercises on the functional fitness in older adults. The SFT was used as a reliable tool to measure functional fitness as well as the effectiveness of the physical intervention in this study. Prior studies have shown that the maintenance of functional fitness can delay health issues related to advancing age. Because exercise can improve functional fitness, it can also help to prevent or reduce fall risk in older adults. Strength-training programs such as the one described in this study can be effective tools for reducing fall risk as well as health care costs, and improving the lives of senior adults and their families.
REFERENCE LIST


The 60 to 64 year old females were within or above normal range for all of the tests except the back scratch. Female posttest scores exceeded criterion fitness standards in half of the tests. The sole male in this age group was only within normal range on the arm curl.
Table 2. Mean ± standard deviation values and SFT-defined range and standards for the 65 to 69 age group

<table>
<thead>
<tr>
<th>Test</th>
<th>Sample (n=27)</th>
<th>SFT-defined range and standards</th>
<th>Sample (n=2)</th>
<th>SFT-defined range and standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest scores</td>
<td>Posttest scores</td>
<td>Normal range</td>
<td>Criterion fitness standards</td>
</tr>
<tr>
<td>Chair stand (# of stands)</td>
<td>12.44 ± 3.65</td>
<td>15.26 ± 4.32</td>
<td>11 to 16</td>
<td>15</td>
</tr>
<tr>
<td>Arm curl (# of reps)</td>
<td>15.89 ± 4.50</td>
<td>19.30 ± 4.00</td>
<td>12 to 18</td>
<td>17</td>
</tr>
<tr>
<td>2-minute step (# of steps)</td>
<td>62.81 ± 28.68</td>
<td>86.11 ± 27.15</td>
<td>73 to 107</td>
<td>93</td>
</tr>
<tr>
<td>Chair sit &amp; reach (inches +/ )</td>
<td>-0.27 ± 3.02</td>
<td>1.32 ± 3.00</td>
<td>-0.5 to 4.5</td>
<td>No standard</td>
</tr>
<tr>
<td>Back scratch (inches +/-)</td>
<td>-1.83 ± 4.12</td>
<td>-2.33 ± 3.88</td>
<td>-3.5 to 1.5</td>
<td>No standard</td>
</tr>
<tr>
<td>8-foot up-and-go (seconds)</td>
<td>6.48 ± 2.17</td>
<td>5.64 ± 1.64</td>
<td>6.4 to 4.8</td>
<td>5.3</td>
</tr>
</tbody>
</table>

The 65 to 69 year old females were within or above normal range for all of the tests except the 2-minute step. Female posttest scores exceeded criterion fitness standards in three of the tests. The males in this age group met or exceeded normal range for all tests.
Table 3. Mean ± standard deviation values and SFT-defined range and standards for the 70 to 74 age group

<table>
<thead>
<tr>
<th>Test</th>
<th>Women Sample (n=24)</th>
<th>Men Sample (n=1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest scores</td>
<td>SFT-defined range and standards</td>
</tr>
<tr>
<td>Chair stand (# of stands)</td>
<td>12.54 ± 3.22</td>
<td>10 to 15</td>
</tr>
<tr>
<td>Arm curl (# of reps)</td>
<td>16.13 ± 3.52</td>
<td>12 to 17</td>
</tr>
<tr>
<td>2-minute step (# of steps)</td>
<td>71.63 ± 30.15</td>
<td>68 to 101</td>
</tr>
<tr>
<td>Chair sit &amp; reach (inches +/-)</td>
<td>1.26 ± 3.80</td>
<td>-1.0 to 4.0</td>
</tr>
<tr>
<td>Back scratch (inches +/-)</td>
<td>-2.20 ± 4.39</td>
<td>-4.0 to 1.0</td>
</tr>
<tr>
<td>8-foot up-and-go (seconds)</td>
<td>7.19 ± 6.15</td>
<td>7.1 to 4.9</td>
</tr>
</tbody>
</table>

* Mean only. No standard deviation due to n = 1.

The 70 to 74 year old females were within or above normal range for all of the tests and female posttest scores exceeded criterion fitness standards for three of the tests. Posttest scores for the lone male in this age group exceeded three of the four criterion fitness standards.
Table 4. Mean ± standard deviation values and SFT-defined range and standards for the 75 to 79 age group

<table>
<thead>
<tr>
<th>Test</th>
<th>Women Sample (n=16)</th>
<th>SFT-defined range and standards</th>
<th>Men Sample (n=4)</th>
<th>SFT-defined range and standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest scores</td>
<td>Posttest scores</td>
<td>Normal range</td>
<td>Criterion fitness standards</td>
</tr>
<tr>
<td>Chair stand (# of stands)</td>
<td>10.56 ± 3.05</td>
<td>12.75 ± 3.26</td>
<td>10 to 15</td>
<td>13</td>
</tr>
<tr>
<td>Arm curl (# of reps)</td>
<td>14.56 ± 3.72</td>
<td>16.44 ± 3.95</td>
<td>11 to 17</td>
<td>15</td>
</tr>
<tr>
<td>2-minute step (# of steps)</td>
<td>63.88 ± 21.55</td>
<td>77.00 ± 21.72</td>
<td>68 to 100</td>
<td>84</td>
</tr>
<tr>
<td>Chair sit &amp; reach (inches +/-)</td>
<td>-1.03 ± 4.37</td>
<td>1.63 ± 2.14</td>
<td>-1.5 to 3.5</td>
<td>No standard</td>
</tr>
<tr>
<td>Back scratch (inches +/-)</td>
<td>-3.49 ± 4.84</td>
<td>-2.50 ± 4.57</td>
<td>-5.0 to 0.5</td>
<td>No standard</td>
</tr>
<tr>
<td>8-foot up-and-go (seconds)</td>
<td>7.58 ± 1.84</td>
<td>6.60 ± 1.88</td>
<td>7.4 to 5.2</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Posttest scores for the 75 to 79 year old females were within normal range for all of the tests. Female posttest scores fell short in three of the criterion fitness standards. The males in this age group met or exceeded normal range for all tests except the chair sit & reach.
Table 5. Mean ± standard deviation values and SFT-defined range and standards for the 80 to 84 age group

<table>
<thead>
<tr>
<th>Test</th>
<th>Pretest scores</th>
<th>Posttest scores</th>
<th>Normal range</th>
<th>Criterion fitness standards</th>
<th>Pretest scores</th>
<th>Posttest scores</th>
<th>Normal range</th>
<th>Criterion fitness standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair stand (no of stands)</td>
<td>12.43 ± 4.28</td>
<td>12.43 ± 3.31</td>
<td>9 to 14</td>
<td>12 **</td>
<td>**</td>
<td>**</td>
<td>10 to 15</td>
<td>13 **</td>
</tr>
<tr>
<td>Arm curl (no of reps)</td>
<td>14.57 ± 6.21</td>
<td>17.86 ± 4.74</td>
<td>10 to 16</td>
<td>14 **</td>
<td>**</td>
<td>**</td>
<td>13 to 19</td>
<td>15 **</td>
</tr>
<tr>
<td>2-minute step (no of steps)</td>
<td>57.00 ± 28.58</td>
<td>79.29 ± 16.12</td>
<td>60 to 90</td>
<td>78 **</td>
<td>**</td>
<td>**</td>
<td>71 to 103</td>
<td>80 **</td>
</tr>
<tr>
<td>Chair sit &amp; reach (inches +/-)</td>
<td>0.07 ± 0.19</td>
<td>1.07 ± 1.21</td>
<td>-2.0 to 3.0</td>
<td>No standard</td>
<td>No standard</td>
<td>**</td>
<td>-5.5 to 1.5</td>
<td>No standard</td>
</tr>
<tr>
<td>Back scratch (inches +/-)</td>
<td>-2.79 ± 2.27</td>
<td>-0.60 ± 4.14</td>
<td>-5.5 to 0.0</td>
<td>No standard</td>
<td>No standard</td>
<td>**</td>
<td>-9.5 to -2.0</td>
<td>No standard</td>
</tr>
<tr>
<td>8-foot up-and-go (seconds)</td>
<td>8.04 ± 2.10</td>
<td>5.64 ± 2.48</td>
<td>8.7 to 5.7</td>
<td>6.5 **</td>
<td>**</td>
<td>**</td>
<td>7.6 to 5.2</td>
<td>6.4 **</td>
</tr>
</tbody>
</table>

** No mean or standard deviation due to n = 0.

The 80 to 84 year old females were within or above normal range for all of the tests except the 2-minute step. Female posttest scores exceeded criterion fitness standards in three of the tests. There were no males in this age group.
Table 6. Mean ± standard deviation values and SFT-defined range and standards for the 85 to 89 age group

<table>
<thead>
<tr>
<th>Test</th>
<th>Sample (n=2)</th>
<th>SFT-defined range and standards</th>
<th>Sample (n=2)</th>
<th>SFT-defined range and standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest scores</td>
<td>Posttest scores</td>
<td>Normal range</td>
<td>Criterion fitness standards</td>
</tr>
<tr>
<td>Chair stand ( # of stands)</td>
<td>4.00 ± 5.66</td>
<td>6.00 ± 8.49</td>
<td>8 to 13</td>
<td>11</td>
</tr>
<tr>
<td>Arm curl ( # of reps)</td>
<td>8.50 ± 0.71</td>
<td>15.50 ± 0.71</td>
<td>10 to 15</td>
<td>13</td>
</tr>
<tr>
<td>2-minute step ( # of steps)</td>
<td>48.50 ± 3.54</td>
<td>88.50 ± 2.12</td>
<td>55 to 85</td>
<td>70</td>
</tr>
<tr>
<td>Chair sit &amp; reach (inches +/-)</td>
<td>-3.50 ± 2.12</td>
<td>-2.75 ± 5.30</td>
<td>-2.5 to 2.5</td>
<td>No standard</td>
</tr>
<tr>
<td>Back scratch (inches +/-)</td>
<td>-10.00 ± 2.83</td>
<td>-9.00 ± 3.54</td>
<td>-7.0 to -1.0</td>
<td>No standard</td>
</tr>
<tr>
<td>8-foot up-and-go (seconds)</td>
<td>15.00 ± 11.31</td>
<td>10.00 ± 4.24</td>
<td>9.6 to 6.2</td>
<td>7.1</td>
</tr>
</tbody>
</table>

* Mean only. No standard deviation due to only 1 recorded pretest score.

Pretest and posttest scores for the 85 to 89 year old females were below normal range for four of the six tests. Female posttest scores fell below criterion fitness standards in two of the tests. The posttest scores for males in this age group did not reach normal range for five of the tests.
Table 7. Mean ± standard deviation values and SFT-defined range and standards for the 90 to 94 age group

<table>
<thead>
<tr>
<th>Test</th>
<th>Women</th>
<th>SFT-defined range and standards</th>
<th>Men</th>
<th>SFT-defined range and standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample (n=2)</td>
<td></td>
<td>Sample (n=1)</td>
<td></td>
</tr>
<tr>
<td>Chair stand (# of stands)</td>
<td>11.50 ± 0.71</td>
<td>15.00 ± 0.00</td>
<td>7.00*</td>
<td>8.00*</td>
</tr>
<tr>
<td>Arm curl (# of reps)</td>
<td>10.50 ± 6.36</td>
<td>17.50 ± 0.71</td>
<td>21.00*</td>
<td>21.00*</td>
</tr>
<tr>
<td>2-minute step (# of steps)</td>
<td>57.50 ± 24.75</td>
<td>58.50 ± 19.09</td>
<td>77.00*</td>
<td>99.00*</td>
</tr>
<tr>
<td>Chair sit &amp; reach (inches +/-)</td>
<td>0.80 ± 0.99</td>
<td>1.50 ± 0.00</td>
<td>-8.00*</td>
<td>-5.00*</td>
</tr>
<tr>
<td>Back scratch (inches +/-)</td>
<td>-3.50 ± 8.49</td>
<td>-3.75 ± 7.42</td>
<td>-3.00*</td>
<td>2.80*</td>
</tr>
<tr>
<td>8-foot up-and-go (seconds)</td>
<td>15.05 ± 8.98</td>
<td>13.10 ± 7.21</td>
<td>15.00*</td>
<td>11.00*</td>
</tr>
</tbody>
</table>

* Mean only. No standard deviation due to n = 1.

The 90 to 94 year old females met or exceeded normal range scores in four of the six tests. Female posttest scores exceeded criterion fitness standards in two of the tests. The posttest scores for the sole male in this age group met or exceeded normal range in five of the six tests.
<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>t-score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 Chair stand</td>
<td>2.75</td>
<td>2.745</td>
<td>10.411</td>
<td>.000</td>
</tr>
<tr>
<td>Pair 2 Arm curl</td>
<td>3.791</td>
<td>5.032</td>
<td>7.901</td>
<td>.000</td>
</tr>
<tr>
<td>Pair 3 2-minute step</td>
<td>19.073</td>
<td>20.170</td>
<td>9.873</td>
<td>.000</td>
</tr>
<tr>
<td>Pair 4 Chair sit &amp; reach</td>
<td>1.556</td>
<td>2.680</td>
<td>6.035</td>
<td>.000</td>
</tr>
<tr>
<td>Pair 5 Back scratch</td>
<td>.696</td>
<td>4.211</td>
<td>1.734</td>
<td>.086</td>
</tr>
<tr>
<td>Pair 6 8-foot up-and-go</td>
<td>1.117</td>
<td>1.905</td>
<td>6.118</td>
<td>.000</td>
</tr>
</tbody>
</table>
APPENDIX

MEMORANDUM

TO: Susie Engle  
    Betsy Garrison

FROM: Ro Windwalker  
    IRB Coordinator

RE: New Protocol Approval

IRB Protocol #: 16-02-504

Protocol Title: Data Analysis of Senior Fitness Test Results from 44 Arkansas Counties

Review Type: ☑ EXEMPT  ☑ EXPEDITED  ☐ FULL IRB

Approved Project Period: Start Date: 02/24/2016  Expiration Date: 02/23/2017

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form Continuing Review for IRB Approved Projects, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vprerp.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 638 participants. If you wish to make any modifications in the approved protocol, including enrolling more than this number, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.
### Brief Summary of Seven Seminal Articles

<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Sample</th>
<th>Purpose</th>
<th>Methods</th>
<th>Type and duration of 'intervention' (if applicable)</th>
<th>Results</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rikli &amp; Jones (2013)</td>
<td>n = 2140</td>
<td>To develop and validate criterion-referenced fitness standards for older adults that predict the level of capacity needed for maintaining physical independence into later life.</td>
<td>A criterion measure to assess physical independence was identified. Scores from a subset of 2140 older adults were used as the basis for proposing fitness standards associated with having the ability to function independently.</td>
<td>Dataset used was from previous research, so no 'intervention' occurred.</td>
<td>Performance standards are presented for men and women ages 60-94 indicating the level of fitness associated with remaining physically independent until late in life.</td>
<td>The standards provide easy-to-use, methods for evaluating capacity in older adults. These standards can be used in planning interventions that target areas of weakness and reduce risk for premature loss of mobility and independence.</td>
</tr>
<tr>
<td>Author(s) and year</td>
<td>Sample</td>
<td>Purpose</td>
<td>Methods</td>
<td>Type and duration of 'intervention' (if applicable)</td>
<td>Results</td>
<td>Implications</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>Santos et al. (2012)</td>
<td>n = 312, 117 males, 195 females (aged 65-103)</td>
<td>To examine the independent impact of objectively measured moderate-to-vigorous physical activity (MVPA) and sedentary time on functional fitness in a sample of community-dwelling adults aged 65 or older.</td>
<td>Participants were assessed for physical activity and sedentary time with accelerometers and for functional fitness with the SFT battery.</td>
<td>The intervention for this study was the actual physical activity performed during the participant’s normal daily routine (as measured by the accelerometer).</td>
<td>Eldely who spend more time in physical activity or less time in sedentary behaviors exhibit improved functional fitness.</td>
<td>The results reinforce the importance of promoting the reduction of sedentary behaviors and the increase of moderate-to-vigorous physical activity (MVPA) in this age group.</td>
</tr>
<tr>
<td>Author(s) and year</td>
<td>Sample</td>
<td>Purpose</td>
<td>Methods</td>
<td>Type and duration of 'intervention' (if applicable)</td>
<td>Results</td>
<td>Implications</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>-------------------------------------------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>Santana-Sosa et al. (2008)</td>
<td>n = 16 6 males, 10 females</td>
<td>To determine the effects of a 12-week training program for Spanish patients with AD on their overall functional capacity and ability to perform ADLs.</td>
<td>All training sessions and evaluations of subjects' functional capacity/ability to perform ADLs/gait and balance abilities were performed in the nursing home. Evaluations were conducted before and after training.</td>
<td>The intervention included a total of 36 programmed training sessions and were supervised by exercise scientists.</td>
<td>Results showed significant improvements after training in upper and lower body muscle strength and flexibility, agility and dynamic balance, and endurance fitness (SFT) and in the ability to perform ADLs independently.</td>
<td>Exercise training could be included in the overall medical/nursing care protocol for patients with AD.</td>
</tr>
</tbody>
</table>
## Brief Summary of Seven Seminal Articles (Cont.)

<table>
<thead>
<tr>
<th>Author(s) and year</th>
<th>Sample</th>
<th>Purpose</th>
<th>Methods</th>
<th>Type and duration of 'intervention' (if applicable)</th>
<th>Results</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thompson et al. (2007)</td>
<td>Exercise group (n = 11 males) Control group (n = 7 males)</td>
<td>To determine the effect of a progressive functional training program on club head speed and functional fitness in older male golfers.</td>
<td>Both exercise and control groups were utilized in the study. Exercise group participated in an 8-week progressive functional training program. Pre and post measurements included club head speed (exercise and control) and the SFT (exercise group only).</td>
<td>The intervention included an 8-week progressive functional training program including exercises for flexibility, core stability, balance, and resistance.</td>
<td>After intervention, the maximal club head speed increased in the exercise group compared with the control group. Improvements were also detected for most SFT variables in the exercise group.</td>
<td>This functional fitness training program resulted in significant improvements in club head speed and several components of functional fitness. Future research should continue to examine the effects of training programs on sport performance in older adults.</td>
</tr>
<tr>
<td>Author(s) and year</td>
<td>Sample</td>
<td>Purpose</td>
<td>Methods</td>
<td>Type and duration of 'intervention' (if applicable)</td>
<td>Results</td>
<td>Implications</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>----------------------------------------------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>Toraman (2005)</td>
<td>Young-old group (aged 60-73 years) n = 22 Old group (aged 74-86 years) n = 20</td>
<td>To assess the effects of short (six weeks) and long (52 weeks) term detraining on functional fitness in elderly people, and to determine whether these effects differ according to age in elderly people.</td>
<td>Elderly subjects, aged 60-86 years, completed a 9-week multicomponent exercise training program. The SFT was performed after six weeks and after 52 weeks. Responses from the 12 young-old and 9 older subjects were compared.</td>
<td>The intervention included aerobic, resistance, and flexibility exercise training under supervision. Training variables for each aspect were specifically adjusted each week.</td>
<td>Functional fitness improved during the exercise training period. Short term detraining caused some loss of improvement in functional performance. After 52 weeks of detraining, performance in all tests reverted to the pre-training value or lower in both groups. In the old group, values were lower than before training.</td>
<td>Components most affected by detraining were agility with short detraining and aerobic endurance and upper extremity strength with long term detraining. Changes in functional capacity after short and long term detraining are affected by age in elderly adults.</td>
</tr>
<tr>
<td>Author(s) and year</td>
<td>Sample</td>
<td>Purpose</td>
<td>Methods</td>
<td>Type and duration of 'intervention' (if applicable)</td>
<td>Results</td>
<td>Implications</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>------------------------------------------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>Toraman &amp; Ayceman</td>
<td>Young-old group (aged 60-73 years) n = 22 Old group (aged 74-86 years) n = 20</td>
<td>To examine the effects of age on functional fitness after six weeks of detraining.</td>
<td>Elderly subjects, aged 60-86 years, completed a 9-week multicomponent exercise training program. The SFT was performed every two weeks during the six weeks detraining period, and the responses of 12 young-old subjects and 9 older subjects were compared.</td>
<td>The intervention included aerobic, resistance, and flexibility exercise training under supervision. Training variables for each aspect were specifically adjusted each week.</td>
<td>Functional fitness improved during exercise training period. Performance in two tests for the Old group declined compared with post - training after two weeks detraining. Scores on the functional fitness test declined further between two and four weeks of detraining in both groups. Significant losses for the Young-old group on three tests, and for the Old group on two tests after six weeks of detraining.</td>
<td>Components most affected by detraining were lower extremity flexibility after two and four weeks detraining, and agility/dynamic balance after six weeks detraining. Changes in lower extremity flexibility, up and go, and six minute walk performances in response to six weeks of detraining are affected by age in elderly adults.</td>
</tr>
<tr>
<td>Author(s) and year</td>
<td>Sample</td>
<td>Purpose</td>
<td>Methods</td>
<td>Type and duration of 'intervention' (if applicable)</td>
<td>Results</td>
<td>Implications</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>---------------------------------------------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>DiBrezzo et al. (2005)</td>
<td>n = 16 3 males, 13 females</td>
<td>To evaluate a simple, low-cost exercise program for community-dwelling older adults.</td>
<td>Sixteen senior adults were evaluated using the SFT for measures of functional strength, aerobic endurance, dynamic balance and agility, and flexibility. Subjects attended a 10-week exercise class.</td>
<td>The 10-week exercise class included stretching, strengthening, and balance-training exercises.</td>
<td>Significant improvements were observed in tests measuring dynamic balance and agility, lower and upper extremity strength, and upper extremity flexibility.</td>
<td>The research indicates that exercise programs such as the one used in this study are an effective, low-cost solution to improving health and factors that affect falling risk among older adults.</td>
</tr>
</tbody>
</table>