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# Effects of an exercise program on functional capacity of older adults

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# EFFECTS OF AN EXERCISE PROGRAM ON FUNCTIONAL CAPACITY OF OLDER ADULTS

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ABSTRACT

EFFECTS OF AN EXERCISE PROGRAM ON FUNCTIONAL CAPACITY OF OLDER ADULTS

By Trinh D. Nguyen

Power training has been shown to improve muscular strength, which translates into better balance and mobility for older adults. Balance and Tai Chi training have been shown to enhance proprioception, which translates into better agility and dynamic balance. The current study investigated the effects of a whole body exercise program, compared to a walking program, on the functional capacity of older adults. For the exercise program, older adults met 2 days per week for 8 weeks and performed warm-up and stretching activities; upper and lower body, abdominal, and balance exercises; and perceptual-motor games. For the walking program, older adults met 2 days per week for 8 weeks and were asked to walk at a comfortable pace. Upper and lower body power was assessed using the 30 s Arm Curl and 30 s Sit-To-Stand tests, respectively. Static balance was assessed by measuring the length of time that participants could balance on one leg with their eyes open. Agility and dynamic balance were assessed using the 8-Foot Up-and-Go test. Although no external weight was used during training, the exercise program enhanced functional capacity by increasing upper and lower body power, improving agility and dynamic balance, and static balance for the right leg. The walking group improved static balance for both the left and right legs. In conclusion, some components of functional capacity can be improved by exercising 2 days per week for 8 weeks using either a structured exercise program or a self-paced walk.

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# Chapter 1

## Introduction

Baby boomers are the largest growing segment of the population (Dionne, Ades, & Poehlman, 2003). Older adults (age 60 and older) are living longer, but some are not independent, especially after a fall (Dionne et al., 2003). Loss of muscle mass and strength are common in the older adult population. A decrease in muscle mass and structural deterioration explain the outcome of sarcopenia, an age-related muscle atrophy process, that occurs during aging (Galban, Maderwald, Stock, & Ladd, 2007). Sarcopenia increases as adults age (Katula, Sipe, Rejeski, & Focht, 2006) and is associated with a decrease in muscle strength, gait, balance, and neural control, resulting in a loss of functional abilities in older adults (Kamel, 2003; Katula et al., 2006). These changes help to explain why older adults react more slowly when their balance is compromised. In addition, loss of muscle strength is predictive of future declines in functional performance in older adults (Kamel, 2003).

Loss of balance in young adults is usually not as significant; they can compensate efficiently because they have adequate neural, sensory, and musculoskeletal control when their balance is out of equilibrium (Maki et al., 2008). However, older adults may not be able to correct a loss of balance, resulting in a fall. Falls in older adults may lead to brain injuries and fractures (Moylan & Binder, 2007), which can potentially increase morbidity (Robitaille et al., 2005). Because of embarrassment, many older adults who have experienced falls may not tell their physicians (Moylan & Binder, 2007). Subsequently, because of their increased fear of falling again, many older adults who previously experienced a fall will decrease their physical activity (Moylan & Binder, 2007). In turn, older adults will reduce their outdoor physical activities due to the increased fear of falling (Wijlhuizen, Jong, & Hopman-Rock, 2007).

*Statement of the Problem*

Fear of falling may lead to decreased physical activity, which accelerates losses of muscle mass, strength, and power. This impairs functional performance and may contribute to a decreased sense of empowerment and self-efficacy, which may further limit physical activity. Power training improves muscle strength in older adults (Barry & Carson, 2004; Behm & Sale, 1993; Krivickas et al., 2006; Orr et al., 2006; Vos et al., 2005). Power training programs have been shown to be beneficial in preventing, delaying, or reversing sarcopenia (Faber, Bosscher, Paw, & Wieringen, 2006). A small number of studies have shown a relationship between balance training and functional capacity (Choi, Moon, & Song, 2005; Robitaille et al., 2005; Takeshima et al., 2007). The use of balance training to improve and restore musculoskeletal function is still being researched (Stel, Smit, Pluijm, & Lips, 2003). Several intervention studies have shown that improvement of mobility and activity can reduce the number of falls; however, it is not clear which type of exercise is most effective (Stel et al., 2003). However, studies have shown that improving functional capacity through an effective balance training program that incorporates dynamic balance, static balance, and lower leg power may decrease falls in older adults (Choi et al., 2005; Faber et al., 2006; Robitaille et al., 2005; Takeshima et al., 2007). There is a need to assess the effects of an exercise program that incorporates balance, power, dynamic agility, and strength elements, using body weight as resistance, on functional capacity of older adults.

*Statement of Purpose*

The purpose of this study was to determine whether an exercise training program that incorporated elements of balance and strength would improve functional capacity in older adults.

*Research Hypothesis*

The exercise training program would improve functional capacity in older adults.

*Delimitations*

1. Participants consisted of men and women who were at least 60 years of age.
2. Participants who used any assistive devices, such as walkers, canes, or wheelchairs, were excluded from the study.
3. Exercises and activities in the Spring Chicken Exercise Curriculum (McClure, 2007) included side leg raise, hip flexion, hip extension, leg curl, tandem walk (4 m), head tilt, chin to chest, chin to shoulder, shoulder stretch, shoulder forward, cat stretch, reach to the sky, alternate shoulder rolls, shoulder lifts, wrist stretch upward and downward, open and close fist, thumb to fingertips, thigh stretch, inner thigh stretch, calf stretch, point and flex ankle, overhead press, lateral raise, upright row, biceps curl, triceps extension, chest scissors, stand-ups, two-leg squat, one-leg squat, heel lifts, heel raise, knee lift, rocking chair, elbow to knee, standing rocking chair, arm swing, stand on one foot, super hero, one-handed scarf catch, two-handed scarf catch, scarf toss, single balloon bounce, double

balloon bounce, balloon balance on arm, balloon balance on leg, and balloon kick. (Refer to Appendix A.)

*Limitations*

1. Since the study measured older adults, results may not be applicable to other age groups.
2. Motivational levels of the participants may have varied, affecting their effort and performance.
3. Participants were volunteers, possibly indicating a positive bias toward physical activity.
4. Participants were asked not to change their daily activities; however, these activities were not controlled.

*Operational Definition of Terms*

- *Balance*: Physical equilibrium; the ability to retain one's balance. Balance is the ability to maintain the body's position over its base of support, whether the base is stationary or moving (Cromwell & Newton, 2004).
- *Fall:* A fall is defined as any unintentional positional change resulting in a person coming to rest on the ground, floor, or lower surface (Choi et al., 2005; Moylan & Binder, 2007).
- *Functional Capacity*: The physiologic capacity to perform normal daily activities safely and independently without undue fatigue (Rikli & Jones, 1999). Static and dynamic balance, agility, and upper and lower body power were measured to assess functional capacity.

- *Muscle Atrophy*: A reduction in muscle mass and quality due to structural changes in the skeletal muscles (Kamel, 2003).
- *Older Adults*: Age 60 years and older (Moylan & Binder, 2007).
- *Rating of Perceived Exertion (RPE):* Subjective measure of how hard the body is working, based on the physical sensations a person experiences during physical activity, including increased heart rate, increased respiration or breathing rate, increased sweating, and muscle fatigue (Borg, 1998).
- *Sarcopenia:* An overall loss of muscle mass and strength due to structural deterioration that occurs during the aging process. Similar to muscle atrophy, but usually reserved for the aging population (Galban et al., 2007).

*Summary*

Older adults are living longer, but some are not independent (Kamel, 2003). Falls in older adults are the leading injury that causes death (Stevens, 2005). In addition, falls may lead to serious brain injuries and fractures (Moylan & Binder, 2007), which can potentially increase morbidity (Robitaille et al., 2005). Sarcopenia occurs during the aging process and is associated with a decrease in muscle strength, gait, balance, and neural control, and loss of functional abilities in older adults (Kamel, 2003; Katula et al., 2006). Neural deterioration explains the increased reaction time that older adults need when their balance is compromised. Loss of balance in young adults is usually not significant. They can compensate more efficiently because they have adequate neural, sensory, and musculoskeletal control when their balance is out of equilibrium (Maki et al., 2008). However, older adults may not be able to correct a loss of balance, resulting in a fall. Subsequently, many older adults who previously experienced a fall will decrease their physical activity level, further decreasing their functional capacity. Many factors, including sarcopenia and impaired balance, contribute to an increased risk of falls in older adults.

Physical activity can positively impact muscle mass and strength, as well as enhance balance, potentially improving functional capacity. Older adults often need encouragement, positive feedback, and patience during training (Cohen, 1988; Katula et al., 2006; Wijlhuizen et al., 2007). If functional capacity is improved, it may decrease the incidence of falls in older adults. An effective training program should incorporate balance, power, aerobic, and flexibility activities (Choi et al., 2005; Faber et al., 2006; Robitaille et al., 2005; Takeshima et al., 2007). There is little research on the effects of an exercise training program that uses body weight as a form of resistance on functional capacity in older adults. The present study will examine the effects of an exercise program that incorporates stretches, body weight strengthening exercises, balance, and perceptual-motor activities to improve functional capacity in older adults.

# Chapter 2

# Review of Literature

Successful balance involves the integration of cognitive, neuromuscular, sensory, and skeletal components (Moylan & Binder, 2007). Each of these systems is affected as a consequence of degeneration or disease with advancing age (Moylan & Binder, 2007). Loss of balance can result in falls, which can be catastrophic in older adults because they can lead to injuries that may decrease independence. This section will review the extrinsic and intrinsic factors that contribute to falls in older adults. Methods of assessing functional capacity will be discussed, as well as the effects of strength and power training on balance. The final sections review studies that have examined the effects of balance and Tai Chi training on functional capacity of older adults.

Falls are the most frequent cause of fatal injury in older adults (Stevens, 2005). A variety of risk factors for falls have been identified, including extrinsic and intrinsic factors. Tinetti et al. (1994) suggested that two-thirds of falls in older adults are potentially preventable; thus, identifying risk factors is an important step toward preventing falls.

*Extrinsic Factors*

Extrinsic factors, such as rugs, poor home lighting, cluttered space, and tripping hazards in the home predispose older adults to falls (Tinetti et al., 1994). Home modifications alone will reduce falls; environmental factors play a part in about half of all home falls (Stevens, 2005). Home assessment and modifications, such as using nonslip mats in the bathtub and on shower floors, grab bars next to the toilet and in the tub or shower, handrails on both sides of stairways, and good home lighting, can significantly reduce falls in older adults (Stevens, 2005; Tinetti et al., 1994).

*Intrinsic Factors*

One intrinsic factor for falls is a loss of muscle strength. As older adults age, their physical activity levels drop, which can lead to muscle atrophy. When healthy muscles are unused, muscle fibers shrink in size (Galban et al., 2007; Young, Stokes, & Crowe, 1985). Low muscle strength is predictive of future declines in functional performance in older adults (Larsson, 1995). Type II muscle fibers decrease with age; Type I fibers tend to retain their size, but decrease in number (Galban et al., 2007; Larsson, 1995; Luff, 1998; Young et al., 1985).

Studies have looked at the cross-sectional geometries of muscle. Galban et al. (2007) used diffusion tensor magnetic resonance imaging to indirectly study microscopic changes in various tissues and found that adjacent fibers in healthy, young muscle have similar cross-sectional geometries. As a result of aging, muscle fibers begin to deform. Some shrink due to disuse, some appear round, and others more elongated. Compared to old muscle, the soleus, medial gastrocnemius, and the plantar flexors were larger in young muscle. The soleus muscle in older adults was 18% smaller than in young adults, and the medial gastrocnemius was 15% smaller. Interestingly, the geometry and structure of the fibers in the plantar flexors were similar between older and younger adults; the fibers in older individuals were simply smaller, which may result from a more sedentary lifestyle.

Young et al. (1985) used ultrasonography and found a 25 to 35% reduction in the cross-sectional area of the quadriceps muscle in older men and women compared with their younger counterparts. The scanning technique showed similar age-related reductions in cross-sectional area of the psoas major and sacrospinalis muscles.

In addition to changes in fiber cross-sectional area, there are also changes in fiber architecture. Electron microscopic studies of muscle biopsy samples have revealed a variety of alterations including "disarrangement of myofilaments and Z-lines, proliferation of the sarcoplasmic reticulum and t-tubular system, and accumulation of lipofuscin and nemaline rod structures" in older adults (Young et al., 1985, p. 147). This suggests that as older adults age, there is structural deterioration. In addition, there is evidence to indicate a loss of motor units as muscles age. Generally, young muscle tissues have a distinct structural appearance. In older adults, muscle fibers tend to have a patchy appearance; this finding has been attributed to incomplete activation of muscle tissue as a result of incomplete innervations (Larsson, 1995; Luff, 1998). This loss appears to be greatest among the largest and fastest Type II motor units. It appears that with increasing age, muscle fibers undergo denervation of motor neurons. The combined changes contribute in large part to the loss of strength observed in older adults.

Another intrinsic factor is a loss of bone mass. Osteoporosis and bone fractures have been well documented as a public health problem in older adults (Sigurdsson et al., 2006). It is important to identify the pathological mechanisms underlying bone fragility in old age and their effects on postural balance. Sigurdsson et al. (2006) looked at bone mineral density (BMD) in the L1, L2 vertebrae, and the proximal femoral neck of older adults using computed tomography images. Results showed that the femoral neck cortical BMD was similar in both sexes, but 4.4% greater BMD in trochanter cortical bone in men. In addition, men had greater trabecular BMD in the lumbar spine and a thicker cortex than women. This shows greater bone resorption in women, signifying a higher fracture incidence in women than men. Based on the local thinning of the superior cortex in women, Sigurdsson et al. proposed that women have a higher incidence of fracture in old age due to smaller bones and an enhanced rate of bone loss during the first year after menopause.

Previous studies have shown a positive correlation between muscle power output and better balance. As the ability to generate muscle power declines, there is a loss of independence in older adults (Anton, Spirduso, & Tanaka, 2004). The ability to perform many activities of daily living may be compromised by low muscle strength and power, even in healthy older adults. Anton et al. found that in trained older athletes, the decline in peak muscle power was greater in very rapid, highly coordinated movement tasks that required good balance.

The level of cognitive function has been identified as another intrinsic factor affecting balance. Maintaining balance involves many factors. Swan, Otani, Loubert, Sheffert, and Dunbar (2004) used dual tasks in which participants simultaneously attempted to maintain balance while performing a secondary cognitive task, such as memorizing and recalling sentences and numbers. Participants performed three practice trials before the actual test in a seated position. They listened to tape-recorded sentences and were then asked to recall as many of the sentences as possible. Following the practice trials, participants were instructed to stand on a force plate and remain still while listening to other taped-recorded sentences, during which postural sway was measured in older and younger adults. Participants verbally recalled the sentences. Participants performed the balance test with their eyes opened and closed. Results showed that after performing a secondary cognitive task, balance was improved in older adults. Swan et al. (2004) concluded that the secondary tasks were not demanding enough for young adults, but were sufficient to cause balance improvement in older adults.

Dizziness, syncope, and functional disabilities, such as gait impairments, have been associated with an increased risk of falls (Grimby & Rosenhall, 1995). Physicians are well aware that as patients age their balance, strength, and flexibility decrease, putting them at higher risk for falls (Robitaille et al., 2005). Chronic diseases, such as Parkinson's, stroke, diabetes, and arthritis, increase the risk of falling (Moylan & Binder, 2007). Along with medical conditions, medications such as sleeping pills and antianxiety drugs increase the likelihood of falls (Moylan & Binder, 2007; Stevens, 2005).

*Assessing Functional Capacity*

Functional capacity is the ability to perform normal daily activities safely and independently without undue fatigue (Rikli & Jones, 1999). The 30 s Sit-To-Stand test has been well established as a measure of lower body power, a component of functional capacity (Rikli & Jones, 1999). Decreases in lower body power have been associated with impairments in gait, stair climbing, rising from a chair, and balance (Rikli & Jones, 1999). In the 30 s Sit-To-Stand test, individuals rise from a seated position to a full standing position as many times as possible in 30 s. Fewer than 10 repetitions may indicate decreased lower leg power. In addition to the 30 s Sit-To-Stand test, the Stand Up and Reach test is also used to assess functional capacity (Robitaille et al., 2005). Older adults should be able to stand in a fixed position and move their fist forward a distance of at least 15 cm without losing balance. Distances less than 15 cm may indicate a decrease in balance and significant risk of falling. The Get-up and Go test is also recommended as a simple, practical test to assess leg strength and functional balance (Robitaille et al., 2005). Participants rise from a chair, walk 10 m around a marked area, and return to a seated position on the chair. The total time to complete the test is recorded. A walking speed of less than 1 m/s may alert health care workers to a greater risk of falls. The slower the time on the Get-up and Go test, the greater the risk of falling (Robitaille et al., 2005). Similar to the Get-up and Go test, the 8-Foot Up-and-Go test measures speed, power, agility, and dynamic balance (Rikli & Jones, 1999). The 8-Foot Up-and-Go is a timed test that involves rising from a seated chair position, walking 8 feet around a cone or marked area, and returning to a seated position. A time of 8 s or more may be a good predictor of decreases in power, agility, and dynamic balance.

Power, agility, and dynamic balance are all important components of functional capacity; however, static balance is also important and serves as a good marker for identifying poor balance (Berg, Wood-Dauphinee & Williams, 1995). The 1-Legged Stance (with or without visual feedback) has been used to assess static balance (Berg et al., 1995; Choi et al., 2005). Older adults should be able to stand on one leg without holding onto a wall or supportive device for at least 3 s. A time of less than 3 s could suggest a significant loss of lower leg strength (Berg et al., 1995). Because the majority of falls occur during walking, turning, or on stairs when older adults are on one leg during mid-stance, single leg static balance is an important skill to assess (Cho, Scarpace, & Alexander, 2004).

Trips and slips are the most common contributors to falls in older adults, and responding to a slip or trip requires taking a step (Cho et al., 2004). Cho et al. (2004) used the maximal step length (MSL) test to examine older adults' ability to step out maximally with one leg while maintaining the stance leg in the initial position, then returning to their initial stance position in one step. Older adults who had previously fallen did not perform as well and took shorter step lengths than nonfallers. Cho et al. (2004) concluded that MSL is a good measure of the strength and power an individual can consistently generate when stepping out and making a return step. Based on this study, the MSL test identifies older adults who are at risk for falls. The ability to maximally step out and safely return to the original position is a display of strength, power, and control, which all play an important role in maintaining balance.

*Strength and Power Training*

Deficits in muscle strength and power hinder the ability of older adults to complete some functional movement tasks, such as rising from a chair, climbing stairs, and walking (Barry & Carson, 2004). The relative importance of maximum muscle strength and power vary depending on the force demands of particular activities. Strength is the ability or capacity to exert maximal force and is not time-dependent (Orr et al., 2006). As the strength levels of older adults decline, movements begin to deteriorate until, eventually, older adults perceive that they are slow or cannot perform the task as frequently as they once did, and a modified strategy is then adopted (Orr et al., 2006).

Power is the ability to accelerate a limb or one's body weight; thus, it requires strength and contractile speed (Orr et al., 2006). Generating muscle power is critical when performing many activities of daily living (Krivickas et al., 2006). Older adults should be able to move from locations in their home safely and timely; however, as they age, their ability to produce muscle power declines (Orr et al., 2006) Therefore, leg muscle power has been identified as a stronger predictor of functional status than strength for community-dwelling older adults with a history of falling. Lower leg muscle power is also an important predictor of stair-climbing and chair-rising performance in older adults (Behm & Sale, 1993; Vos et al., 2005).

Compared to older men, older women tend to have greater functional impairment and a longer period of dependence before death. Sex-related differences in the ability of skeletal muscle to generate force and power may be largely responsible for this phenomenon. This is clinically relevant because leg extensor power is highly correlated with functional capacity performance measures such as stair climbing and walking speed. In fact, poor leg extensor power can be a predictor of morbidity and mortality (Krivickas et al., 2006). Power production is influenced by the central nervous system (Krivickas et al., 2006). Krivickas et al. (2006) looked at power capacity of a single muscle fiber in relation to the influence of the central nervous system. On the whole muscle level, men generated greater knee extensor and double leg press strength, power, and velocity than did women, but no significant sex differences were seen in single muscle fibers, suggesting that single muscle fiber power is equivalent in older men and women.

A decreased ability to develop force rapidly also seems to be associated with a lower capacity for the neuromuscular response necessary to control postural sway (Barry & Carson, 2004). Lower limb power is a significant factor in maintaining balance in older adults. Orr et al. (2006) examined the effects of power training on balance. Participants trained 2 days a week for 12 weeks at 20% (LOW), 50% (MED), or 80% (HIGH) of the maximal weight they could lift one time (1-RM). Exercises included horizontal leg press, knee extension, knee flexion, seated row, and seated chest press, with participants performing 3 sets of 8 rapid concentric/slow eccentric repetitions. When retested on the force plate, participants who power trained at LOW loads showed the greatest improvements in balance, measured by postural sway. In contrast, Vos et al. (2005) found comparable power gains using 20, 50 and 80% of 1-RM; however, gains in strength and muscle endurance were greater with heavier loads. Thus, power can be achieved across a variety of loads, but training at a lighter load should enhance compliance in older adults (Barry & Carson, 2004; Orr et al., 2006).

In summary, loss of muscle strength and power are common in the older adult population (Orr et al., 2006). Power gains can be achieved at various training loads; however, lower load, high velocity training may be safer and enhance compliance in older adults (Orr et al., 2006; Vos et al., 2005). Power training should be incorporated into everyday routines to counteract the muscle deterioration and loss of functional movement capacities in older adults. In addition, power training improves balance and increases strength (Orr et al., 2006; Vos et al. 2005).

*Balance Training*

Reactions to a loss of balance require rapid volitional limb movement, such as initiating or modifying a step, or rapidly reaching out and grasping an object for support (Maki et al., 2008). As a consequence of age-related deterioration in the neural, sensory, and musculoskeletal systems, older adults may have slower reaction times when they have a misstep, increasing their risk of falls (Maki et al., 2008). Many older adults are not able to quickly react when their balance is suddenly disrupted.

Maki et al. (2008) used change-in-support reactions as a training device to reduce the age-related deterioration in the neural, sensory, and musculoskeletal systems. Participants wore a safety harness anchored to the ceiling and performed lateral, forward, and backward stepping while reaching for handrails on an unbalanced force plate. Perturbations of the force plate were administered in an unpredictable manner, varied in time and magnitude to stimulate and train the central nervous system (CNS) and improve the efficacy of the balance reactions. Training progressed by adding more weight to the safety harness to increase the level of difficulty and improve adaptation. In later sessions, concurrent cognitive and movement tasks were included to distract participants from the balance task and provide a more realistic simulation of the demands of controlling balance in daily life. Results indicated that neuromuscular facilitation and proprioception improved as a result of the training program.

Faber et al. (2006) compared two exercise programs in prefrail and frail older adults. The first program, functional walking (FW), consisted of exercises that focused on balance, mobility, and transfer training. In the second program, in balance (IB), exercises were inspired by the principles of Tai Chi. However, in a population with limited mobility, Tai Chi forms are less suitable because of balance and coordination challenges. Therefore, specific adjustments were made. The IB program included elements of Tai Chi that have been identified as most beneficial for elderly persons. In the beginning of the program, attention was paid to somatosensory feedback signals coming from ankle and hip motions. As motion, proprioception, and sensation improved, Tai Chi forms were introduced with emphasis on slow and continuous motions, trunk rotation, and weight shifting. Because of fatigue or poor balance control, participants were allowed to perform some exercises in a sitting position, with individual modifications. The frequency and duration of the sessions were the same for both programs. Each program started with 1 session per week for 4 weeks to familiarize the group with the exercise program, followed by twice-weekly sessions for 16 weeks. Each session lasted 90 min, including a 30-min social component of sitting together with a drink, intended to maintain and increase motivation. After a 52 week follow up, the fall incidence rate was higher in the FW compared to the IB group. This was attributed to a lack of lateral stability in the FW group. However, Faber et al. (2006) concluded that both the FW and IB programs were effective for decreasing the number of falls and improving physical performance in prefrail, but not frail adults. Moderate intensity programs and the opportunity to socialize were key elements in sustaining exercise participation of older adults (Faber et al., 2006). Faber et al. (2006) recommended including group exercise programs as part of a fall-preventive intervention for prefrail elderly only. For frail elderly, safety-enhancing interventions, such as environmental modifications, might be preferable to training. However, Tai Chi exercises that incorporate the same elements, but are practiced at a slower and more controlled pace, may yield similar results and be easier for older adults to perform.

*Tai Chi Exercises*

Tai Chi is an ancient Chinese martial art that incorporates elements of strength, balance, postural alignment, and concentration. Tai Chi exercise has been recently used with older adults for fall prevention (Choi et al., 2005; Robitaille et al., 2005; Takeshima et al., 2007). Older adults enjoy Tai Chi exercise because it can be performed at any time and place without special equipment. Choi et al. (2005) focused on increasing knee and ankle muscle strength, balance, flexibility, and mobility using the Sun-style Tai Chi exercise. This exercise was chosen because it is suitable to the physical condition of older adults, and the motions have a higher stance than other Tai Chi styles. The Tai Chi program consisted of a 10 min warm-up, 20 min of 12 Tai Chi movements, and a 5 min cool down. To warm up, participants walked while moving their hands and greeting each other in the group, followed by exercises that focused on the neck, shoulders, trunk, hip, knees, and ankles. The 12 forms of the Tai Chi exercise involved bending the knees in wide steps. The cool down included stretches for the arm and leg muscles, and breathing exercises. After 12 weeks, the exercise group significantly improved knee and ankle strength, mobility, flexibility, and balance with eyes open. Knee and ankle muscle strength were measured using a manual muscle tester. Balance was assessed by how long the participant could stand on one foot with eyes open or closed. Flexibility was measured in a seated position by bending forward at the waist, stretching both hands toward the feet without bending the knees, and measuring the distance between the hands and the feet. Mobility was measured by the time taken to walk 6 m on a marked floor. Choi et al. (2005) noted that in addition to improved strength and balance, the Sun-style Tai Chi exercise also enhanced self-efficacy. Older adults felt more confident to engage in outdoor activities after their Tai Chi exercise.

Although studies have used different exercise modes, it is not clear how each specific mode of exercise affects the individual components of functional fitness in older adults. Takeshima et al. (2007) compared different forms of training in a group of community dwelling older adults. Training programs included a walking-based aerobic program, a theraband-based resistance program, a stretching-based flexibility program, a customized balance program, and a Tai Chi program. All training programs were supervised for 12 weeks. For the aerobic intervention (AER), participants met 3 days a week for 90 min at the park near the university and were instructed to walk continuously around the park, achieving a heart rate (HR) of 100-120 beats per minute. Maximal heart rate (HRmax) was not measured directly; however, a HR of 100-120 beats per minute represented an intensity of 70-80% of HRmax for people approximately 70 years of age. For the resistance intervention (RES), participants met 2 days a week and performed elastic band-based resistance exercises for all major muscle groups. Resistance was progressively increased every 2-4 weeks by advancing to the next color of elastic band.

Specifically, participants were instructed to change bands when they were able to perform 20 repetitions of a given motion with little exertion, rated using Borg's RPE scale (Borg, 1998). Participants were instructed to start resistance exercises at an intensity level of 11-13 (fairly light to somewhat hard) and then to progressively increase to a level of 15-17 (hard to very hard). For the flexibility intervention (FLEX), participants performed 15 static stretches for the upper and lower body while sitting or lying on exercise mats. Stretches were performed slowly, holding each position for 15-20 s. For the balance intervention (BAL), participants met 2 days a week and performed customized balance exercises designed to challenge the visual (e.g., open/close eyes), vestibular (e.g., move head), and somatosensory (e.g., stand on foam) systems. Exercises were initially performed while standing on the floor (first 4 weeks) and then progressed to standing on foam pads. For the Tai Chi intervention (T-Chi), participants performed a 24 form Yang-style Tai Chi exercise, the most popular form of Tai Chi. Each session was led by a Tai Chi master.

Results showed that there was no change over time in the FLEX group on any measure. Takeshima et al. (2007) suggested that the back scratch and sit and reach test, which were used to measure flexibility, may not have been sensitive enough to detect changes, or that the training stimulus was insufficient to promote improvement. Although the FLEX program did not result in improvements, flexibility training is recognized as an important component of a well-rounded exercise program and, thus, should be included (Takeshima et al., 2007). The RES, BAL, and T-Chi training modes all resulted in improved strength after 12 weeks. Upper body strength and endurance was assessed using the 30 s Arm Curl test (Rikli & Jones, 1999). Lower body strength and endurance was assessed using the 30 s Sit-To-Stand test (Rikli & Jones, 1999). Balance and agility were assessed using the 8-Foot-Up-and-Go test (Rikli & Jones, 1999).

The RES training program resulted in greater improvement in upper body strength than the BAL and T-Chi programs, indicating the specificity of this training mode. In the T-Chi and BAL groups, participants made frequent hand movements that were controlled and semi-isometric in nature while performing their group-specific exercises, likely explaining the modest improvement in upper body strength. With respect to lower body strength, RES, BAL, and T-Chi training were all effective. It appears that balance training is most effective and results in greater lower body strength gains. Only the AER group improved cardiorespiratory fitness, measured using the 12 min walk test. Takeshima et al. (2007) suggested that training components can cross over into domains not specifically targeted in their design, so that the combination of aerobic exercise (e.g., walking) and a second mode with crossover effects could improve multiple components of functional fitness. When choosing the second mode, the needs of the older adult should be considered. If improved balance is the goal, resistance and balance programs should be considered. If lower body strength is the focus, older adults may wish to participate in balance training because it produced significantly greater lower body strength gains compared to RES or T-Chi. With respect to upper body strength, the RES program was most effective and should be recommended, although gains can also be achieved through BAL or T-Chi training. T-Chi exercise was effective at improving muscle strength and balance, which could help decrease the risk of falls in older adults.

Falls contribute significantly to morbidity among older adults, and loss of balance is an important risk factor for falls (Robitaille et al., 2005). A few studies have shown that specific exercise programs can improve balancing ability; however, little is known about the success of these programs when broadly delivered in an older adult community setting. Robitaille et al. (2005) used a group-based exercise intervention program to improve balance in older adults. The intervention consisted of 2 day per week, group-based, exercise sessions conducted over 12 weeks by a professional, coupled with home-based exercises. The program included movements derived from Tai Chi and leg-strengthening exercises with elastic bands of varying thickness. Participants were also invited to exercise on their own at home, at least once per week, with the help of a poster depicting 12 exercises. Robitaille et al. (2005) focused on enhancing proprioception, leg strength, and ankle mobility, incorporating Tai Chi's principle of controlled movements. Robitaille et al. (2005) measured the following dimensions of balance: (1) static balance (one legged stance with eyes open and closed, and tandem stance test), (2) stability limits (functional reach and lateral reach tests), and (3) mobility (tandem walk). The strength of lower extremity muscles was measured using the Sit-To-Stand test. Compared to a control group, the exercise intervention resulted in improved performance on all static balance indicators except the lateral reach. Robitaille et al. (2005) concluded that a structured, group-based exercise program offered in a community center successfully increased static balance and mobility among older adults.

*Summary*

Falls and fall-related injuries represent an enormous burden to older adults and may lead to complications such as a loss of independence and increased medical costs. Older adults should be encouraged to remain physically active to prevent functional decline and falls (Katula et al., 2006; Maki et al., 2008; Moylan & Binder, 2007; Robitaille et al., 2005; Stevens, 2005; Takeshima et al., 2007). Slow and controlled exercise programs such as Tai Chi, coupled with an aerobic program significantly improved strength, balance, and cardiovascular endurance (Choi et al., 2005; Takeshima et al., 2007). Although different exercise modes produce specific exercise results, there may also be cross over with improvement in domains not specifically targeted in the design. For example, resistance training may improve balance, and balance training may improve strength (Choi et al., 2005; Takeshima et al., 2007). In conclusion, to improve functional capacity in older adults, an effective exercise program should address multiple components of fitness such as strength, balance, and agility.

# Chapter 3

# Methods

The purpose of this study was to examine the effects of an exercise program on static and dynamic balance, agility, and lower body power, which are components of functional capacity. This section describes the manner in which this study was executed. The participants, testing procedure, research design, and statistical analyses are described.

*Participants*

Participants were recruited from the Alviso Senior Center, Hank Lopez Community Center, and the Salvation Army in San Jose, CA. These sites served primarily low income, Spanish speaking older adults. A total of 34 participants were recruited for both the exercise ($n$=25) and the walking (control) groups ($n$=9). There were more participants in the exercise group because they were recruited from two sites; one site was available for the walking group. Participants who were under the age of 60 and/or who used any assistive device such as walkers, canes, or wheelchairs were allowed to participate in the exercises, but were excluded from the study. Three of the participants from the exercise group who performed the initial pretest were not available during the 9$^{th}$ week for the posttest. Additionally, 5 of the participants from the walking group who performed the initial pretest chose not to participate, citing personal reasons and boredom. Data from these 8 participants were excluded from the analyses. The mean age (± SD) of the older adults who participated in the exercise portion of this study was 75.6 ± 7.5 years (range 61–87 years). This group consisted of 16 women and 6 men. The mean age (± SD) of the older adults who completed participation in the walking group was 65.7 ± 2.2 years (range 63-68 years). This group consisted of 3 women and 1 man.

*Testing Procedure*

Consistent with American College of Sports Medicine recommendations (Whaley, 2006), participants were asked to refrain from eating, smoking, and ingesting caffeine 3 hr prior to testing. Participants were asked to stay hydrated prior to each training or testing session and obtain sufficient sleep for the entire 8 week study. Participants were asked to wear loose exercise clothing to permit full range of motion. One week prior to beginning the exercise program, participants were asked to come to the testing site and perform initial balance and functional tests. Height and weight were also measured. Posttests were done in the $9^{th}$ week.

The 30 s Sit-To-Stand test was used to assess lower body power. The Sit-to-Stand test was selected because it is sensitive at detecting age declines in leg power (Rikli & Jones, 1999). Loss of lower body strength has been associated with the deterioration of a number of performance variables such as gait, climbing stairs, and rising from a chair. In the 30 s Sit-To-Stand test, older adults rose to a full standing position from a seated position on a chair as many times as possible in 30 s.

The 1-Legged Stance test was used to assess static balance and stability. This test required participants to stand on one leg as long as possible with eyes open. The 1-Legged Stance test is a simple, yet reliable procedure to assess static balance (Berg et al., 1995).

To assess agility, speed, and dynamic balance, participants performed the 8-Foot Up-and-Go test (Rikli & Jones, 1999). Participants rose from a seated chair position, walked 8 feet around a cone, and returned to a seated position as quickly as possible. The 8-Foot-Up-and-Go reflects common mobility and gait maneuvers required for independent living, such as getting up from a chair to answer the phone or door, and getting on and off buses in a timely manner. In addition, the 8-Foot-Up-and-Go test has been found to be a good predictor of functional capacity and has good test-retest reliability (Rikli & Jones, 1999).

To assess upper body power, participants performed the 30 s Arm Curl test. Participants performed as many arm curls as possible in 30 s with their dominant arm (Rikli & Jones, 1999). The Arm Curl test was chosen because upper body strength is important in executing many normal, everyday activities such as household chores, carrying groceries, and picking up a suitcase. This test was chosen because correlations with upper body strength were .81 and .78 for men and women, respectively (Rikli & Jones, 1999), which supports validity of the test. Both upper and lower body power are required for independent living. Tests are described in detail in Appendix B.

*Research Design*

The exercise and walking programs were performed 2 days a week for 8 weeks. The exercise group met Mondays and Wednesdays, while the walking group met Wednesdays and Fridays. Pretests were done 1 week prior to the training program, and posttests were completed during the 9$^{th}$ week. Participants were asked to maintain their current daily physical activities throughout the duration of the study.

Participants were randomly assigned to either the exercise or walking (control) group. Participants completed a medical and activity history form (Appendix C). The procedures, risks, and benefits were explained to each participant, after which the consent form was signed (Appendix D). The study was approved by the university's Institutional Review Board.

*Exercise program group.* This group performed the Spring Chicken Curriculum designed by McClure (2007). The program included exercises that address upper body, lower body, and abdominal muscles. Participants were asked to maintain exercise intensity between very light to somewhat hard (RPE 9-13). In addition, stretches, balance activities, and perceptual-motor games were included. The games were low impact and required minimal physical exertion for most adults. A full description of the exercises is in Appendix E. Total exercise time was approximately 45-60 min. The objective of the exercise program was to increase participants' ability to complete each exercise for the amount of time or number of repetitions described in Appendix E. Participants were asked to wear loose fitting, comfortable clothing and athletic shoes. Exercises were performed according to the protocol in Appendix E. Instructions and visual examples of each exercise were provided. Participants were encouraged to ask questions for clarification or stop at any time during the session if training became too intense. Due to the heterogeneity of the group, some of the older adults were able to complete all the exercises, while other participants needed rest breaks. Participants were asked to put forth their best effort and progress at their own pace. This exercise training program was used because fall prevention programs should incorporate elements of strength, agility, dynamic balance, and flexibility, all components of functional capacity. While there may be some neural facilitation after one training session, neural adaptation and muscular gains peak after 8 weeks of training (Orr et al., 2006; Vos et al., 2005).

*Walking (control) group.* The walking group was asked to walk outside around the senior center for 30-45 min, 2 days a week for 8 weeks. Speed was self-paced; however, participants were asked to maintain a walking speed between very light to somewhat hard according to the RPE scale (9-13). RPE was recorded at the end of each walking session. All walking sessions were supervised.

*Statistical Analyses*

The independent variable in the study was the intervention, the exercise program. The walking group served as a control. Dependent variables were the repetitions for the 30 s Sit-To-Stand test, time for the 1-Legged Stance test, time for the 8-Foot Up-and-Go test, and number of repetitions completed during the 30 s Arm Curl test. Means and standard deviations are reported. A two-way repeated measures analysis of variance (ANOVA) was initially used to examine the effects of the exercise and walking programs on each dependent variable. Because the data did not meet the normality assumption for a two-way repeated measures ANOVA, paired comparisons were made between pre and posttest results for the exercise program and walking groups. Paired t-tests were used when the normality assumption was met. A Wilcoxon Signed Rank Test was used when the paired t-test normality assumption was not met. All data were computed using the SigmaStat 3.5 program.

# Chapter 4

## Results

Older adults either participated in the exercise or walking programs 2 days per week for 8 weeks. There were a total of 16 activity sessions. Compliance ranged from 9 to 16 sessions for the exercise group and 9 to 13 sessions for the walking group.

In the exercise group, 16 of the 18 participants improved lower body power as measured by the 30 s Sit-To-Stand test. Pre and posttest scores were the same for 1 participant and lower on the posttest for the other. Upper body power, measured by the 30 s Arm Curl test, improved in 14 participants, remained the same for 3, and decreased for 1 older adult. Agility and dynamic balance, measured by the 8-Foot Up-and-Go test, improved in 14 participants and decreased in 4 older adults. Results for static balance, measured by the 1-Legged Stance test, were more variable. The number of participants who increased, maintained, and decreased time on the 1-Legged Stance test were 12, 1, 5 for the right leg and 11, 1, 6 for the left leg. Posttest improvements were statistically significant for all tests except the 1-Legged Stance on the left leg.

The 4 participants in the walking group improved on all measures of functional capacity. However, because of the small number of participants in this group, improvements in static balance (right and left legs) were the only statistically significant changes. The small sample size was due to the limited number of participants recruited from only one site. Due to the language barrier, many participants either dropped out or cited boredom as their primary reasons for discontinuing the walking program.

Table 1 show the exercise group pre and posttest data. Table 2 shows the walking group pre and posttest data. Although the older adults were randomly assigned to the exercise or walking groups, participants from the exercise group were older ($p < 0.05$). There was no significant height difference between the exercise and walking groups. Weight was constant over the 8 week study, and there was no significant difference between the two groups.

Table 1. Exercise Group Pre and Posttest Results

| | **Pretest** | **Posttest** |
|---|---|---|
| Height (in) | 62.1 ± 3.2 | |
| Weight (lbs) | 146.6 ± 23.4 | 147.0 ± 23.5 |
| 1-Legged Stance (R) (s) | 20.61 ± 42.74 | 26.74 ± 43.46* |
| 1-Legged Stance (L) (s) | 20.80 ± 41.56 | 23.52 ± 40.89 |
| 30 s Sit-To-Stand (reps) | 12.8 ± 4.4 | 15.4 ± 5.7* |
| 30 s Arm Curls (reps) | 15.2 ± 6.6 | 19.3 ± 7.3* |
| 8-Foot Up-and-Go (s) | 7.55 ± 1.61 | 6.43 ± 1.26* |

Note. * $p < 0.05$ compared to pretest

Table 2. Walking Group Pre and Posttest Results

| | Pretest | Posttest |
|---|---|---|
| Height (in) | 62.5 ± 1.7 | |
| Weight (lbs) | 165.6 ± 33.9 | 164.9 ± 34.6 |
| 1-Legged Stance (R) (s) | 15.87 ± 9.05 | 27.90 ± 10.25* |
| 1-Legged Stance (L) (s) | 16.30 ± 10.59 | 28.22 ± 13.22* |
| 30 s Sit-To-Stand (reps) | 12.5 ± 1.7 | 14.8 ± 1.7 |
| 30 s Arm Curls (reps) | 16.8 ± 3.3 | 23.8 ± 6.9 |
| 8-Foot Up-and-Go (s) | 6.73 ± 0.40 | 5.95 ± 1.15 |

Note. * $p < 0.05$ compared to pretest

There was a significant difference between pre and posttest results for the 8-Foot Up-and-Go test using the two-way repeated measures ANOVA. There was no significant difference in scores between the two groups. However, the data did not meet the normality assumption, so differences between pre and posttest results were examined for the exercise and walking groups separately using paired t-tests. There was a significant difference for the exercise group, $t(21) = 4.935$, $p < 0.001$, but not for the walking group.

Similar results were found for the 30 s Arm Curl test. There was a significant difference between pre and posttest results using a two-way repeated measures ANOVA. However, the data did not meet the normality assumption, so differences between pre and posttest results were examined for the exercise and walking groups separately. Because the exercise program results did not meet the normality assumption for a paired t-test, differences in median scores were examined using the Wilcoxon Signed Rank Test.

Median values were 13.5 and 17.0 curls on the pre and posttest, respectively, $Z = 3.630$, $p < 0.001$. Pre and posttest results for the walking group approached statistical significance, $t(3) = -3.080$, $p = 0.054$. However, the power was 0.510, below the desired power of 0.800.

For the 30 s Sit-To-Stand test, again the two-way repeated measures ANOVA did not meet the normality assumption. There was a significant difference between the pre and posttest results for the exercise program, $t(21) = -3.778$, $p = 0.001$. For the walking group, the normality assumption for a paired t-test was not met. There was no significant difference between the pre and posttest median values.

For the 1-Legged Stance tests, data did not meet the normality assumption for the two-way repeated measures ANOVA. For the right leg, both groups showed significant improvement as a result of the 8 week training program. Median values for the exercise group were 4.74 s (pre) and 8.78 s (post), $Z = 2.311$, $p = 0.022$. Mean values for the walking group were 15.87 s (pre) and 27.90 s (post), $t(3) = -7.894$, $p = 0.004$. For the left leg, there was no significant difference for the exercise group, but there was a significant improvement for the walking group, $t(3) = -4.768$, $p = 0.018$.

# Chapter 5

## Discussion

The results indicate that performing the Spring Chicken Exercise Curriculum (McClure, 2007) 2 days a week for 8 weeks can improve upper and lower body power, measured by the Arm Curl and Sit-To-Stand tests, and agility and dynamic balance, measured by the 8-Foot Up-and-Go test. In addition, static balance improved on the right leg. These are important components of functional capacity for older adults.

Age may be one predictor of physical decline, but strength, power, agility, and balance can be gained at any age. Functional capacity varies in older adults; some are very fit, while others have functional limitations. A chair-based exercise program may be particularly suitable for individuals who find standing activities too difficult (Takeshima et al., 2007). The uniqueness of the Spring Chicken Exercise Curriculum is that the program has many exercises that are chair-based; however, it can be modified for individuals who vary in functional capacity. In addition, the exercise program used no external weights, which increased the ability of low income participants to exercise at home.

Because of the small number of participants in the walking group, static balance was the only component of functional capacity that showed statistically significant changes. However, all participants in the walking group improved in all measures of functional capacity. Although specificity of training is well recognized, Takeshima et al. (2007) suggested that training components can cross over into domains not specifically targeted in their design. The walking program targeted aerobic fitness; however, other components of functional capacity were positively affected. These results are supported by Faber et al. (2006) who suggested that walking was an effective exercise program for improving balance and decreasing number of falls in older adults.

Although participants in the exercise and walking groups improved functional capacity, the percentage of older adults that completed the 8 week program was greater in the exercise group compared to the walking group. Over 50% of the participants assigned to the walking group chose not to participate after completing the pretest, citing personal reasons and, also, the time of each walking session coincided with their bingo time. A language barrier also contributed to the loss of participants in the walking group. Many of the older adults in the walking group were Spanish speakers, which explains the lack of opportunity to socialize and connect with the instructor.

In contrast, the Spring Chicken Exercise Curriculum was designed to be interactive and enjoyable. The program incorporated teamwork; teams were formed during the game section and remained together throughout the 8 week study, giving the older adults an opportunity to get to know each other, socialize, and feel a sense of responsibility to their teammates. Participants felt that the exercise program was not only physically and mentally stimulating, but also very interactive, which made it more enjoyable. Additionally, the importance of exercising and living a more active lifestyle was taught. Benefits were related to participants' lives. For example, by gaining strength, they would be more capable of picking up their grandchildren with less effort, or doing household chores with ease.

In contrast to the 12 week programs used by Choi et al. (2005), Robitaille et al. (2005), and Takeshima et al. (2007), the present study used an 8 week intervention using body weight as resistance. Older adults improved functional capacity, supporting the conclusion of Robitaille et al. (2005) that a structured, group-based program can successfully increase functional abilities and may also allay age-related neuromuscular degeneration.

*Psychological Benefits*

When older adults are told about the risk of falls, they tend to reduce their level of physical activity because of their increased fear of falling (Moylan & Binder, 2007). Thus, a decrease in the number of falls is achieved at the cost of decreased physical activity in the elderly population (Wijlhuizen et al., 2007). A fear of falling can lead to depression; the loss in sense of power can be just as devastating, if not worse, than the fall (Moylan & Binder, 2007). Group-mediated psychological empowerment interventions coupled with a strength-training program have been shown to produce greater self-efficacy than strength training alone. Katula et al. (2006) found that through self-empowerment, older adults became more active. Owsley et al. (2006) encouraged older adults to speak out about their shared experience, enhancing communication and building confidence. Expressing emotions helped many older adults cope with their depression, frustration, fear, and feelings of inadequacy. Enhanced self-efficacy and confidence may contribute to a more physically active lifestyle, enhancing functional capacity.

Participants were asked not to change their daily activity routine for the course of the 8-week study, but a few participants who noticed a change in their strength felt compelled and motivated to perform more vigorous activities outside of the exercise class. This suggests that as older adults become more active and restore some of their strength, physical activity can improve self-efficacy, the sense of control over one's environment, and the ability to function effectively (Jones & Rose, 2005; Katula et al., 2006; Moylan & Binder, 2007; Owsley et al., 2006; Wijlhuizen et al., 2007).

While the focus of this study was to evaluate the effectiveness of an exercise program that incorporated stretches, body weight strengthening exercises, balance, and perceptual-motor activities for improving functional capacity in older adults, it would be imprudent to ignore the potential psychological benefits that may have resulted, including enhanced self-efficacy and the desire for a higher quality of life. Many of the participants who were truly engaged in the present 8-week exercise program noted changes in their own lifestyles that were carried over from the exercise sessions to their everyday activities.

The present results indicate that improvement in functional capacity can be achieved with light-to-moderate effort and exertion, as seen with both the exercise and walking groups. Only one person did not improve on any posttest; however, this participant showed up for only 9 of the 16 scheduled sessions. Intensity for the Spring Chicken Curriculum was set at a very light to somewhat hard level. Participants in the walking group selected a pace that was comfortable relative to their abilities.

In summary, participating in the 8-week Spring Chicken exercise program significantly improved multiple components of functional capacity. The group-based program facilitated interaction among participants and enhanced compliance.

*Future Directions*

Participants in this study were primarily low income, Spanish-speaking, older adults. The exercise and walking programs were conducted at community centers that served this population. A language barrier affected the opportunity for the instructor and participants to socialize, contributing to the large dropout rate in the walking group. The exercise program retained more participants because the participants could learn the exercises by watching the instructor's visual cues. Future studies could address the language barrier by having a bilingual group leader, which may enhance compliance. One of the limitations of this program was the short time frame. Even though improvements occurred in 8 weeks without external weights, future studies could lengthen the program to 3 days per week for 12 weeks and use weights or therabands to increase resistance.

References

Anton, M. M., Spirduso, W. W., & Tanaka, H. (2004). Age-related declines in anaerobic muscular performance: Weightlifting and powerlifting. *Medicine and Science in Sports and Exercise, 36*, 143-147.

Barry, B. K, & Carson, R. G. (2004). The consequences of resistance training for movement control in older adults. *Journal of Gerontology, 59*, 730-754.

Behm, D. G., & Sale, D. G. (1993). Intended rather than actual movement velocity determines velocity-specific training response. *Journal of Applied Physiology, 7*, 359-368.

Berg, K., Wood-Dauphinee S., & Williams, J. I. (1995). The balance scale: Reliability assessment for elderly residents and patients with an acute stroke. *Scandinavian Journal of Rehabilitation Medicine, 27,* 27-36.

Borg, G. (1998). *Borg's perceived exertion and pain scales.* Champaign, IL: Human Kinetics.

Cho, B. L., Scarpace, D., & Alexander, N. B. (2004). Tests of stepping as indicators of mobility, balance, and fall risk in balance-impaired older adults. *Journal of the American Geriatrics Society, 52,* 1168-1173.

Choi, J. H., Moon, J. S., & Song, R. (2005). Effects of Sun-style tai chi exercise on physical fitness and fall prevention in fall-prone older adults. *Journal of Advanced Nursing 51,* 150-157.

Cohen, E. (1988). The elderly mystique: Constraints on the autonomy of the elderly with disabilities. *The Gerontologist, 28,* 24-31.

Cromwell, R. L., & Newton, R. A. (2004). Relationship between balance and gait stability in healthy older adults. *Journal of Aging and Physical Activity, 11,* 90-100.

Dionne, I. J., Ades, P. A., & Poehlman, E. T. (2003). Impact of cardiovascular fitness and physical activity level on health outcomes in older persons. *Mechanisms of Ageing and Development, 124*, 259-267.

Faber, M. J., Bosscher, R. J., Paw, M. J. C. A., & Wieringen, P. C. V. (2006). Effects of exercise programs on falls and mobility in frail and pre-frail older adults: A multicenter randomized controlled trial. *Physical Medicine and Rehabilitation, 87,* 885-896.

Galban, C. J., Maderwald, S., Stock, F., & Ladd, M. E. (2007). Age-related changes in skeletal muscle as detected by diffusion tensor magnetic resonance imaging. *Journal of Gerontology. 62,* 453-458.

Grimby, A., & Rosenhall, U. (1995). Health-related quality of life and dizziness in old age. *Gerontology, 41,* 286-298.

Jones, C. J., & Rose, D. J. (2005). *Physical activity instruction of older adults.* Champaign, IL: Human Kinetics.

Kamel, H. K. (2003). Sarcopenia and aging. *Nutrition Review, 61,*157-167.

Katula, J. A., Sipe, M., Rejeski, W. J., & Focht, B. C. (2006). Strength training in older adults: An empowering intervention. *Medicine and Science in Sports and Exercise, 38,* 106-111.

Krivickas, L. S., Fielding, R. A., Murray, A., Callahan, D., Johansson, A., Dorer, D. J., et al. (2006). Sex differences in single muscle fiber power in older adults. *Medicine and Science in Sports and Exercise, 38,* 57-63.

Larsson L. (1995). Motor units: Remodeling in aged animals. *Journal of Gerontology, 50,* 91-95.

Luff, A. R. (1998). Age-associated changes in the innervation of muscle fibers and changes in the mechanical properties of motor units. *Annals of the New York Academy of Sciences, 854,* 92-101.

Maki, B. E., Cheng, K. C. C., Mansfield, A., Scovil, C. Y., Perry, S. D., Peters, A. L., et al. (2008). Preventing falls in older adults: New interventions to promote more effective change-in-support balance reactions. *Journal of Electromyography and Kinesiology, 18,* 243-254.

McClure, D. (2007). Spring chicken curriculum. Unpublished manuscript, San Jose, CA, 2-159.

Moylan, K. C., & Binder, E. F. (2007). Falls in older adults: Risk assessment, management and prevention. *American Journal of Medicine, 120,* 493-497.

Orr, R., Vos, N. J., Singh, N. A., Ross, D. A., Stavrinos, T. M., & Fiatarone-Singh, M. A. (2006). Power training improves balance in healthy older adults. *Journal of Gerontology, 61,* 78-85.

Owsley, C., McGwin, G., Jr., Scilley, K., Dreer, L. E., Bray, C. R., & Mason, J. O., III (2006). Focus groups with persons who have age-related macular degeneration: Emotional issues. *American Psychological Association, 51,* 23-29.

Rikli, R. E., &, Jones, J. (1999). Development and validation of a functional fitness test for community-residing older adults. *Journal of Aging and Physical Activity, 7,* 129-161.

Robitaille, Y., Laforest, S., Fournier, M., Gauvin, L., Parisien, M., Corriveau, H., et al. (2005). Moving forward in fall prevention: An intervention to improve balance among older adults in real-world settings. *American Journal of Public Health, 95,* 2049-2056.

Sigurdsson, G., Aspelund, T., Chang, M., Jonsdottir, B., Sigurdsson, S., Eiriksdottir, G., et al. (2006). Increasing sex difference in bone strength in old age: The age, gene/environment susceptibility-reykjavik study. *Bone, 39*, 644-651.

Stel, V. S., Smit, J. H., Pluijm, S. M. F., & Lips, P. (2003). Balance and mobility performance as treatable risk factors for recurrent falling in older persons. *Journal of Clinical Epidemiology, 56,* 659-668.

Stevens, J. A. (2005). Falls among older adults—risk factors and prevention strategies. *Journal of Safety Research, 36*, 409-411.

Swan, L., Otani, H., Loubert, P. V., Sheffert, S. M., & Dunbar, G. L. (2004). Improving balance by performing a secondary cognitive task. *British Journal of Psychology, 95,* 31-40.

Takeshima, N., Rogers, N. L., Rogers, M. E., Islam, M. M., Koizumi, D., & Lee, S. (2007). Functional fitness gain varies in older adults depending on exercise mode. *Medicine and Science in Sports and Exercise, 11,* 2036-2043.

Tinetti, M. E., Baker, D. I., McAvay, G., Claus, E. B., Garrett, P., Gottschalk, M., et al. (1994). A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *New England Journal of Medicine, 331*, 821-827.

Vos, N. J., Singh, N. A., Ross, D. A., Stavrinos, T. M., Orr, R., & Fiatarone-Singh, M. A. (2005). Optimal load for increasing muscle power during explosive resistance training in older adults. *Journal of Gerontology, 60,* 638-647.

Whaley, M. H. (Ed.). (2006). *ACSM's guidelines for exercise testing and prescription* (7th ed.). Baltimore: Lippincott William & Wilkins.

Wijlhuizen, G. J., Jong, R., & Hopman-Rock, M. (2007). Older persons afraid of falling reduce physical activity to prevent outdoor falls. *Preventive Medicine, 44,* 260-264.

Young, A., Stokes, M., & Crowe, M. (1985). Size and strength of the quadriceps muscle of old and young men. *Clinical Physiology, 5*, 145-154.

APPENDIX A

Spring Chicken Exercise Curriculum
Modified from McClure, 2007, pp. 9-117

Approximate Exercise Time: 45-60 min

**Warm-up and Stretching Activities:**

- **Head Tilt:** Sit tall on a chair with back straight. Hands are resting comfortably on your lap. Begin by tilting head side to side, moving ear toward your shoulder. Feel the stretch along the neck and hold for 10 seconds. Return head to an upright position and do the stretch 2 times on each side.
- **Chin to Chest:** Sit on a chair in an upright position with a straight back, looking straight forward. Begin by lowering chin toward chest, hold it down for 10 seconds, and bring head back to an upright position. Do this slowly 2 times.
- **Chin to Shoulder:** Sit on a chair in an upright position with a straight back and with the head facing forward, looking straight ahead. Turn head toward the right, looking over shoulder, and hold it for about 5 seconds; then bring it back to an upright position. Do the same toward the left shoulder.
- **Shoulder Stretch:** Sit tall on a chair with back straight and looking forward. Begin by bringing one arm across the body, resting on shoulder. Using the other hand, gently pull elbow farther across body. Feel the stretch along the back of the shoulder. Hold for 10 seconds. Release the stretch and switch arms. Do this stretch 2 times with each arm.

- **Shoulder Forward:** This is done in a standing position. Begin by slowly bending the spine down with hands placed on the front of thighs. Alternate pressing one shoulder forward and then the other. Do this 10 times for each shoulder.
- **Cat Stretch:** This is done in a standing position. Begin by slowly bending the spine, hands placed on the front of the thighs for support. Knees should be bent, feet separated for good balance, and back straight. Round back upward while contracting buttocks and abdominal muscles, then return to starting position. Do this 5 times.
- **Reach to the Sky:** This is done in a standing upright position. Fingers are spread apart and arms are straight up in the air. Without hand weights, alternate stretching one arm and then the other high overhead.
- **Alternate Shoulder Rolls:** This is done in a standing position. Stand with feet shoulder width apart for balance. Alternate circling one shoulder, then the other backward. Do this 10 times for each shoulder.
- **Shoulder Lifts (Shrug):** This is done in a standing position. It may be performed by alternating each shoulder or both shoulders at one time. Bring shoulders up to the ears, then lower. Do this 10 times.
- **Wrist Stretch Upward:** This may be done in a standing or sitting position. Begin by extending one arm straight in front of the body, palm down, elbow locked. Using the other hand, gently pull fingers back. Hold for 10 seconds. Release the stretch and do this 2 times for each wrist.

- **Wrist Stretch Downward:** This may be done in a standing or sitting position. Begin by extending one arm straight in front of the body, palm down, elbow locked. Using the other hand, gently pull fingers downward and back. Hold for 10 seconds. Release the stretch and do 2 times with each wrist.
- **Open and Close:** This may be done in a standing or sitting position. Begin by extending both arms straight out. Alternate spreading fingers apart and then making a fist. Do this 10 times.
- **Thumb to Fingertips:** This may be done in a standing or sitting position. Begin by pulling thumb inward to touch the tip of each finger, one at a time, forming a circle with each finger. Perform with one or both hands; do 10 times.
- **Thigh Stretch:** Stand tall with feet apart. Place one hand on the back of a sturdy chair or stand next to a wall for balance. With the other hand, grasp one foot and bring the heel to buttocks; do not bend at the waist. Feel the stretch in front of the thigh; hold the stretch for 10 seconds, then release. Repeat the stretch 2 times with each leg.
- **Inner Thigh Stretch:** Stand with feet in a wide stance. Stand next to a sturdy chair or a wall for balance. To begin, bend one knee and lunge to the side. Feel the stretch in the inner thigh on the opposite leg. Hold the stretch for 10 seconds and release. Repeat this stretch 2 times for each leg.
- **Calf Stretch:** Stand tall with one foot in front of the other. Place both hands on a sturdy chair or a wall for support. Lean forward while maintaining chin up and

the back leg straight. The front leg should be slightly bent. Hold the position for 10 seconds and release. Do this stretch 2 times for each calf.

- **Point and Flex:** This may be done in a sitting or standing position. In the standing position, the feet should be parallel to each other while holding onto the back of a sturdy chair or a wall. Slowly raise one foot up and point one foot at a time. Flex and extend the ankle while pointing with the toes. Do this 5 times with each foot. Afterward, rotate the foot clockwise and counterclockwise 5 more times with each foot.

**Upper Body Strength Training Exercises:**

- **Overhead Press:** In a standing or sitting position, begin with arms bent at the sides of body, palms facing front. Raise arms straight up, and then return to the starting position. Do this 10 times.
- **Lateral Raise:** In a standing position with feet shoulder width apart, begin with arms relaxed in front of the body, palms facing inward. Lift arms out to the sides, and then return to the starting position. Do this 10 times.
- **Upright Row:** In a standing position with feet shoulder width apart, begin with arms relaxed in front of the body, palms facing inward. Lift hands straight up to chest level, and then return to starting position. Do this 10 times.
- **Biceps Curls:** In a standing position with feet shoulder width apart, begin with arms relaxed in front of the body and palms facing upward. Bend elbows to bring hands upward toward shoulders, and then return to the starting position. Do this 10 times.

- **Triceps Extension:** In a standing position with feet shoulder width apart, begin with arms bent at sides of body, elbows pointing backwards, palms facing the chest. Straighten the arms, press gently upward toward the back, and then return to the starting position. Do this 10 times.
- **Chest Scissors:** In a standing position with feet shoulder width apart, begin with elbows bent and pointed toward the back, palms facing downward. Move arms forward to cross at the front with the wrists touching. Alternate scissoring one wrist atop of the other. Do this 10 times.

**Lower Body Strength Training Exercises:**

- **Stand-ups:** Sit on the edge of the chair and place your hands on your thighs. Your feet should be flat to the floor and toes pointing straight ahead. Stand up from the chair. Stand tall for 2 s and then return to the seated position. Do this 10 times.
- **Two-leg Squat:** Holding onto the back of a sturdy chair, stand with feet parallel to each other and shoulder width apart. Bend both knees while maintaining a straight, upright posture. Pause briefly and straighten knees slowly to standing position. Repeat 10 times, rest for a min, then do a second set of 10.
- **One-leg Squat:** Holding onto the back of a sturdy chair, put right foot forward and bend knees. Maintain an upright position throughout the exercise. Hold the position for a few sec and slowly straighten knees to the standing position. Repeat 10 times. Rest for a min and do 10 more squats.

- **Heel Lifts (both feet):** Stand tall and place both hands on the back of a sturdy chair. Raise both feet off the floor. Feel the muscles working on the ankles and calves. Slowly return to the ground and do this 10 times. Rest for a minute, then do 10 more times.
- **Heel Raise (one foot):** Stand on one foot and place both hands on the back of a sturdy chair for balance. Raise heel off the floor. Slowly lower heel to the ground. Do this 10 times with each foot.
- **Hip Extension:** Place both hands on the back of a sturdy chair. While keeping one foot firmly on the floor, tighten buttocks and lift the other leg backwards, keeping knees straight. Hold for a second and bring it back to original position. Repeat 10 times, rest for a minute, and do 10 more times.
- **Leg Curl:** Place both hands on the back of a sturdy chair. While keeping one foot firmly on the floor, bend other knee, bringing heel toward buttocks. Repeat 10 times for each leg.
- **Side Leg Raise:** Stand sideways with feet together and one hand on the back of a sturdy chair. Maintain an upright posture throughout the exercise. Keep the foot nearest to the chair firmly on the floor, with the knee slightly bent. Tighten buttocks and slowly lift other leg out to the side, hold for a second, and slowly return to the starting positing. Repeat 10 times for each side.

- **Hip Flexion:** Stand sideways with feet together and one hand on the back of a sturdy chair. Maintain upright posture throughout the exercise. Bring one knee up to hip level. Slowly lower foot back to the floor. Repeat 10 times with each leg.

**Stomach Exercises:**

- **Knee Lift:** To begin, sit on the edge of a chair. Place hands on stomach and tighten those muscles. Slowly draw right knee up, then down. Repeat with other knee. Repeat 10 times with each leg.
- **Rocking Chair:** Begin by sitting on the edge of a chair with arms out in front and fingers pointing straight. Slowly lean back until about to touch the back of the chair. Slowly lean forward as if to reach for something way ahead, but keep back straight. Arms are straight, locking the elbow the whole time. Repeat the rocking motion 15 times, rest for one minute, and repeat for another count of 15.
- **Elbow to Knee:** Begin by sitting on the edge of a chair. Position feet hip width apart. Try to keep fingers on top of the shoulders and drop right elbow to right knee. Move back to center and drop left elbow to left knee. Repeat 10 times, rest for a minute, then repeat for 10 more counts.

**Balance Exercises:**

- **Standing Rocking Chair:** For this exercise, you are in a standing position. Place right foot forward and left foot back. Both arms are straight back. Begin rocking forward toward front foot while swinging arms forward. Arms reach out in front as weight shifts to the front foot. Now swing arms backward and shift weight to the back foot. Repeat this rocking motion 15-20 times, switch legs, and repeat the same rocking motion for 15 more times.

- **Arm Swing:** Stand with feet shoulder width apart. Begin by swinging arms to the left side of the body while slightly lifting the right leg. Now swing arms to the right while lifting left leg slightly. Repeat this motion slowly and smoothly 15-20 times.
- **Stand on One Foot:** Place hands on hips or keep both arms to the sides of the body. Bend right knee back and stand on the left foot only. Standing close to a sturdy chair in case of a loss of balance, attempt to stand on the left foot for about 30 s. Repeat, attempting to balance on the right foot for a count of 30 s.
- **Super Hero:** Start in a standing position with both arms out in front, open fist and fingers pointing forward. Slowly raise right foot out behind and try to keep leg straight. Attempt to hold this position for about 30 s. Repeat this same position with the other foot behind. Be close to a sturdy chair in case of loss of balance.
- **Tandem Walk 4 m:** Place both hands on hips or down at the sides of the body. Start with left foot in front of the right foot so the heel of the left foot is almost touching the toes of the right foot. Begin walking in a straight line by placing the right foot in front of the left foot so that the heel of the right foot is now touching or close to the left toes.

**Games:**

- **One-handed Scarf Catch:** Start in a standing position with a scarf in the right hand. Throw the scarf in the air and catch the scarf with the same hand. Continue catching scarf for one minute. Repeat Scarf Catch with the left hand for one minute. Try to minimize movement during the throw and the catch.
- **Two-handed Scarf Catch:** Start in a standing position with each hand holding one scarf. Throw both scarves in the air and try to catch both scarves at the same time. Continue for one minute. Try to minimize movement during the throw and the catch.
- **Scarf Toss:** Start in a standing position with a scarf in the right hand. Throw the scarf up in the air and catch it with the left hand. Continue to throw from one hand to the other for one minute. Try to minimize movement during the throw and the catch.
- **Single Balloon Bounce:** Start in a standing position and try to bounce a balloon in the air and keep it in the air for one minute. Try to minimize movement during the balloon bounce.
- **Double Balloon Bounce:** Start in a standing position. Start bouncing two balloons in the air and keep them in the air for 30 s.
- **Balance Balloon on Arm:** Start in a sitting position. Try to balance a balloon on your arm for 30 s without bouncing it. Repeat with other arm. Try to minimize movement.

- **Balance Balloon on Leg:** Start in a sitting position and try to balance a balloon on your leg for 30 s. Repeat with other arm.
- **Balloon Kick (with or without chair):** Kick a balloon in the air and try to keep it up in the air for 30 s. Hold onto a chair for support if needed.

APPENDIX B
Description of Tests

**The 30 s Sit-To-Stand test**

Place a straight-back or folding chair (without arms) with a seat height of 17 inches against a wall.

The test begins with the participant seated in the middle of the chair, back straight and feet flat on the floor. Arms are crossed at the wrists and held against the chest. On the signal "go" the participant rises to a full stand and then returns to a fully seated position. The participant is encouraged to complete as many full stands as possible within 30 s. After demonstration by the tester, a practice trial of one to three repetitions should be done to check for proper form, followed by one 30-s trial.

Scoring. The score is the total number of stands executed correctly within 30 s. If the participant is more than half-way up at the end of 30 s, it counts as a full stand (Rikli & Jones, 1999, p. 155).

**The 8-Foot Up-and-Go test**

Place a straight-back or folding chair (without arms) with a seat height of 17 inches against a wall. A cone marker is placed 8 feet from the chair (measured from the front edge of the chair to the back of the cone).

The test begins with the participant fully seated in the chair (erect posture), hands on thighs and feet flat on the floor (one foot slightly in front of the other). On the signal "go" the participant gets up from the chair (pushing off thighs or chair is allowed), walks as quickly as possible around the cone placed (on either side), and returns to the chair. The participant should be told that this is a timed test and that the object is to walk as quickly as possible (without running) around the cone and back to the chair. The tester should serve as a spotter, standing midway between the chair and the cone, ready to assist the participant in case of a loss of balance. For reliable scoring, the tester must start the timer on "go," whether or not the participant has started to move, and stop the timer at the exact instant the participant sits in the chair. After a demonstration, the participant walks through the test one time as a practice and then is given two test trials. Participants should be reminded that the timing does not stop until they are fully seated in the chair. Scoring. The score is the time elapsed from the signal "go" until the participant returns to a seated position in the chair. Record both test scores to the nearest $1/10^{th}$ s and circle the best score (lowest time). The best score is used to evaluate performance (Rikli & Jones, 1999, p. 160).

**1-Legged Stance test**

Test will be performed with eyes open.

The test begins with the participant standing, feet shoulder width apart, with hands placed on the hips for balance or out to the side. On the signal "go", the participant will lift the left leg off the floor and remain still while balancing on the right leg. The participant will be encouraged to balance on one leg as long as possibe. Time will be recorded from the time the left leg is lifted off the floor until it touches the floor, or when the participant starts to pivot or hop. The same procedure will be used for the right leg. Three trials will be performed on each leg, with the best trial for each leg recorded. One min of rest will be given between each trial (Berg et al., 1995, p. 27).

**30 s Arm Curl test**

Place a straight-back or folding chair (without arms) with a seat height of 17 inches against a wall.

The participant is seated on a chair, back straight and feet flat on the floor, with the dominant side of the body close to the side edge of the chair. The weight is held at the side in the dominant hand (handshake grip). The test begins with the arm down beside the chair, perpendicular to the floor. At the signal "go" the participant turns the palm up while curling the arm through a full range of motion and then returns to the fully extended position. At the down position the weight should have returned to the handshake grip position.

The examiner kneels (or sits in a chair) next to the participant on the dominant-arm side, placing his or her fingers on the person's mid-biceps to prevent the upper arm from moving and to ensure that a full curl is made (participant's forearm should squeeze examiner's fingers). It is important that the participant's upper arm remain stabilized (still) throughout the test.

The examiner may also need to position his or her other hand behind the participants' elbow so that the participant will know when full extension has been reached, as well as to prevent a back-swinging motion of the arm.

The participant is encouraged to execute as many curls as possible with the 30-s time limit. After a demonstration by the examiner, a practice trial of one or two repetitions should be given to check for proper form, followed by one 30-s trial.

Scoring. The score is the total number of curls made correctly within 30 s. If the arm is more than halfway up at the end of the 30 s, it counts as a curl (Rikli & Jones, 1999, p. 156).

## Appendix C
## Medical and Activity History

1.) Name______________________________________________________

Age__________________ Date of Birth____________________

Phone ___________________________ (work) ____________________ (home or cell)

e-mail _______________________________

Address:______________________________________________________________

Person to contact in case of emergency: _______________________________________

Relationship to you ______________________________Phone____________________

Personal physician _______________________________Phone __________________

I certify that, to the best of my knowledge, the information on the Medical and Activity History (3 pages), dated ____________, is accurate and true.

Signature
_______________________________________________Date______________________

* * * * * * * * * * * *

2.) Have you ever been diagnosed as having any of the following symptoms or conditions?

| | Yes (√) |
|---|---|
| Heart attack | _____ |
| Stroke | _____ |
| Transient ischemic attack | _____ |
| Chest pain | _____ |
| Peripheral vascular disease | _____ |
| Heart surgery | _____ |
| High blood pressure | _____ |
| High cholesterol | _____ |
| Diabetes | _____ |
| Respiratory disease | _____ |
| Osteoporosis | _____ |
| Parkinson's disease | _____ |

Multiple Sclerosis _____
Polio or postpolio syndrome _____
Epilepsy or seizures _____
Rheumatoid arthritis _____
Other arthritic conditions _____
Visual or depth perception problems _____
Inner ear problems or recurrent ear infections _____
Please describe any other health concerns:

________________________________________________________________________

_______________________________________________________________.

3.) Do you currently have a medical condition that might limit your physical performance? No__Yes__ If yes, please describe the condition(s):_____________________________________________.

4.) Do you have a pacemaker? No__Yes__ Does it automatically resuscitate? No__Yes__

5.) Do you currently have any medical conditions for which you see a physician regularly? No___Yes___ If yes, please describe the condition(s):__________________
_______________________________________________________________________.

6.) Have you required emergency medical care or hospitalization in the last three years? No___Yes___ If Yes, please state when this occurred and briefly explain why:_________
_______________________________________________________________________.

7.) Do you need assistive device for walking? No____ Yes____ Sometimes____
Type:_________________________________

8.) How would you describe your health?
Excellent____ Very good____ Good____ Fair____ Poor____

9.) List the prescription medications that you currently take (by exact name or by type):

| Type of medication | For what condition |
| --- | --- |
| __________________________ | ______________________ |
| __________________________ | ______________________ |
| __________________________ | ______________________ |
| __________________________ | ______________________ |

10.) How many times have you fallen within the past year? _____
Did you require medical treatment? No____ Yes____
11.) Have you ever had any conditions or suffered any injury that has affected your balance or ability to walk without assistance? No___ Yes____
If Yes, please list when this occurred and briefly explain the condition or injury:_______

______________________________________________________________________________.

12.) Please list all other types of exercise activities (other than walking) that you usually do each week.
Check the one category that best describes your current level of physical activity:

___ Inactive: Most of your day is spent sitting, and you do no regular physical activity.

___ Somewhat Active: Your day requires some physical activity, and you occasionally participate in recreational activities (e.g., tennis, golf), or you occasionally do physical activities such as gardening, housecleaning, dancing, etc.

___ Moderately Active: Your day requires physical activity and/or you participate in regular recreational or fitness activities (e.g., walking, jogging, swimming, cycling, and weightlifting) for at least 20 min, 3 days each week.

___ Very Active: Your day requires extensive physical activity and/or you exercise moderately to vigorously for more than 30 min, 4 or 5 days each week.

* Adapted from Jones & Rose (2005).

Thank You!

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Appendix D

**Agreement to Participate in Research**

Responsible Investigator(s): Trinh D. Nguyen, B.S.
Peggy Plato, Ph.D.
Title of Protocol: Effects of a Comprehensive Exercise Program on Functional Capacity of Older Adults.

1. I have been asked to participate in a research study investigating the effects of an exercise program on functional capacity (muscle strength and endurance, agility, and balance). The program will take place at the Salvation Army and the Alviso Senior Center in San Jose, CA. I have been asked to participate 2 days/week for 8 weeks. Each exercise session will last approximately 1 hour. The types of exercises include warm-up and stretching activities (e.g., shoulder stretch, calf stretch), upper body exercises (e.g., shoulder presses, arm curls), lower body exercises (e.g., stand-ups, leg raises), abdominal exercises (e.g., knee lifts), balance exercises (e.g., standing on one foot), and games (e.g., scarf toss and catch, balloon bounce). Each exercise will be performed for 10-30 sec. No external weights will be used. At the end of each exercise session, I will be asked to rate my level of perceived exertion.
2. I will be asked to complete a medical history form. In the week before and after the 8 week training program, my functional capacity will be measured, including my height and weight. Functional capacity will be evaluated as follows:
   (a) Static balance will be measured by the number of seconds I can balance on one leg with my eyes open.
   (b) Lower body strength will be measured by the number of times I can rise from a chair in 30 s, with my arms folded across my chest.
   (c) Upper body strength will be measured by the number of times I can lift a hand weight in 30 s (5 pound weight for women, 8 pound weight for men).
   (d) Agility/dynamic balance will be measured by how long it takes me to rise from a chair, walk 8 feet, turn, and return to the chair.
4. The risks associated with this program are minimal, but the exercises performed during the testing and training sessions may cause some immediate and delayed muscle soreness and physical fatigue. My heart rate and blood pressure may increase during the activity. The occurrence of a serious risk, such as a heart attack or stroke, is rare. However, if I experience any unusual pain, including discomfort in my chest, arms, neck, or back; dizziness; fatigue; nausea; muscle cramps or lightheadedness, I should notify the exercise leader. The risks are minimized because all exercises will be performed at my own pace and comfort level. I may stop or rest at any time. If a serious, life-threatening emergency occurs, paramedics (911) will be called. If I experience minor injuries, I should seek medical attention, at my own expense.

Initials ___________

**The California State University:**
Chancellor's Office
Bakersfield, Channel Islands, Chico, Dominguez Hills, East Bay, Fresno, Fullerton, Humboldt, Long Beach, Los Angeles, Maritime Academy, Monterey Bay, Northridge, Pomona, Sacramento, San Bernardino, San Diego, San Francisco, San José, San Luis Obispo, San Marcos, Sonoma, Stanislaus

4. I may benefit by improving my functional capacity, as well as gaining knowledge about my functional capacity.
5. I understand that the results of this study may be published or presented, but no information that could identify me will be included.
6. I understand I will not be financially compensated for participating in this study.
7. Questions I have about this research may be addressed to Trinh D. Nguyen (trinhdnguyen19@gmail.com) or at (408) 515-5538. Complaints about the research may be presented to Shirley Reekie, Ph.D., Chair, Dept. of Kinesiology, at (408) 924-3010. Questions about research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2427.
8. No service of any kind, to which I am otherwise entitled, will be lost or jeopardized if I choose not to participate in the study.
9. My consent is being given voluntarily. I may refuse to participate in the entire study or in any part of the study. If I decide to participate in the study, I am free to withdraw at any time without any negative effect on my relations with San Jose State University or Generations Community Wellness Organization.
10. At the time that I sign this consent form, I will receive a copy of it for my records, signed and dated by the investigator.

- **The signature of a subject on this document indicates agreement to participate in the study.**

- **The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.**

____________________________ ____________________
Participant's Signature Date

____________________________ ____________________
Investigator's Signature Date

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***Department of Kinesiology***

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**Agreement to Participate in Research (Walking Group)**

Responsible Investigators: Trinh D. Nguyen, B.S. (graduate student)
Peggy Plato, Ph.D.

Title of Protocol: Effects of a Comprehensive Exercise Program on Functional Capacity of Older Adults

1. I have been asked to participate in a research study investigating the effects of an exercise program on functional capacity (muscle strength and endurance, agility, and balance). The program will take place at the Hank Lopez Senior Center in San Jose, CA. I have been asked to participate 2 days/week for 8 weeks. Each exercise session will last approximately 1 hour and consist of walking at a comfortable pace that I select. At the end of each exercise session, I will be asked to rate my level of perceived exertion.
2. I will be asked to complete a medical history form. In the week before and after the 8 week training program, my functional capacity will be measured, including my height and weight. Functional capacity will be evaluated as follows:

   (a) Static balance will be measured by the number of seconds I can balance on one leg with my eyes open.

   (b) Lower body strength will be measured by the number of times I can rise from a chair in 30 s, with my arms folded across my chest.

   (c) Upper body strength will be measured by the number of times I can lift a hand weight in 30 s (5 pound weight for women, 8 pound weight for men).

   (d) Agility/dynamic balance will be measured by how long it takes me to rise from a chair, walk 8 feet, turn, and return to the chair.
3. The risks associated with this program are minimal, but the functional capacity measurements and walking may cause some immediate and delayed muscle soreness and physical fatigue. My heart rate and blood pressure may increase during the activity. The occurrence of a serious risk, such as a heart attack or stroke, is rare. However, if I experience any unusual pain, including discomfort in my chest, arms, neck, or back; dizziness; fatigue; nausea; muscle cramps or lightheadedness, I should notify the exercise leader. The risks are minimized because all activities will be performed at my own pace and comfort level. I may stop or rest at any time. If a serious, life-threatening emergency occurs, paramedics (911) will be called. If I experience minor injuries, I should seek medical attention, at my own expense.

Initials ____________

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**Agreement to Participate in Research (Walking Group)**

Responsible Investigators: Trinh D. Nguyen, B.S. (graduate student)
Peggy Plato, Ph.D.

Title of Protocol: Effects of a Comprehensive Exercise Program on Functional Capacity of Older Adults

1. I have been asked to participate in a research study investigating the effects of an exercise program on functional capacity (muscle strength and endurance, agility, and balance). The program will take place at the Hank Lopez Senior Center in San Jose, CA. I have been asked to participate 2 days/week for 8 weeks. Each exercise session will last approximately 1 hour and consist of walking at a comfortable pace that I select. At the end of each exercise session, I will be asked to rate my level of perceived exertion.
2. I will be asked to complete a medical history form. In the week before and after the 8 week training program, my functional capacity will be measured, including my height and weight. Functional capacity will be evaluated as follows:

   (a) Static balance will be measured by the number of seconds I can balance on one leg with my eyes open.

   (b) Lower body strength will be measured by the number of times I can rise from a chair in 30 s, with my arms folded across my chest.

   (c) Upper body strength will be measured by the number of times I can lift a hand weight in 30 s (5 pound weight for women, 8 pound weight for men).

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3. The risks associated with this program are minimal, but the functional capacity measurements and walking may cause some immediate and delayed muscle soreness and physical fatigue. My heart rate and blood pressure may increase during the activity. The occurrence of a serious risk, such as a heart attack or stroke, is rare. However, if I experience any unusual pain, including discomfort in my chest, arms, neck, or back; dizziness; fatigue; nausea; muscle cramps or lightheadedness, I should notify the exercise leader. The risks are minimized because all activities will be performed at my own pace and comfort level. I may stop or rest at any time. If a serious, life-threatening emergency occurs, paramedics (911) will be called. If I experience minor injuries, I should seek medical attention, at my own expense.

Initials ____________

4. I may benefit by improving my functional capacity, as well as gaining knowledge about my functional capacity.

5. I understand that the results of this study may be published or presented, but no information that could identify me will be included.

6. I understand I will not be financially compensated for participating in this study.

7. Questions I have about this research may be addressed to Trinh D. Nguyen (trinhdnguyen19@gmail.com) or at (408) 515-5538. Complaints about the research may be presented to Shirley Reekie, Ph.D., Chair, Dept. of Kinesiology, at (408) 924-3010. Questions about research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2427.

8. No service of any kind, to which I am otherwise entitled, will be lost or jeopardized if I choose not to participate in the study.

9. My consent is being given voluntarily. I may refuse to participate in the entire study or in any part of the study. If I decide to participate in the study, I am free to withdraw at any time without any negative effect on my relations with San Jose State University or Generations Community Wellness Organization.

10. At the time that I sign this consent form, I will receive a copy of it for my records, signed and dated by the investigator.

- **The signature of a subject on this document indicates agreement to participate in the study.**
- **The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.**

| | |
|---|---|
| ______________________ | ______________ |
| Participant's Signature | Date |
| ______________________ | ______________ |
| Investigator's Signature | Date |

Appendix E
Raw Data from Tests

| Exercise Group: Pretest Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Participants | Age (yrs) | Height (inches) | Weight (lbs) | 1-Legged Stance (Right Leg) (s) | 1-Legged Stance (Left Leg) (s) | 30 s Chair Stand (reps) | 30 s Arm Curls (reps) | 8-Foot Up-and-Go (s) |
| 1 (female) | 67 | 59 | 108 | 4.43 | 4.95 | 10 | 11 | 7.12 |
| 2 (female) | 77 | 60 | 158.6 | 7.03 | 7.24 | 8 | 10 | 8.78 |
| 3 (female) | 75 | 60 | 177.8 | 10.56 | 15.52 | 11 | 8 | 6.95 |
| 4 (female) | 77 | 57 | 135.6 | 11.77 | 5.13 | 19 | 21 | 7.36 |
| 5 (female) | 72 | 58 | 105.4 | 2.52 | 1.80 | 11 | 10 | 8.28 |
| 6 (female) | 66 | 63 | 129 | 103.09 | 89.43 | 14 | 13 | 4.63 |
| 7 (male) | 80 | 64 | 165 | 7.27 | 21.50 | 15 | 24 | 5.35 |
| 8 (male) | 77 | 66 | 153.4 | 35.39 | 11.70 | 12 | 10 | 7.28 |
| 9 (male) | 85 | 65 | 174.6 | 5.41 | 4.99 | 18 | 18 | 6.82 |
| 10 (male) | 61 | 67.5 | 147.4 | 180 | 180 | 28 | 37 | 3.80 |
| 11 (male) | 83 | 68 | 145.8 | 2.09 | 2.80 | 9 | 10 | 10.00 |
| 12 (female) | 68 | 62 | 175.6 | 10.61 | 32.39 | 12 | 16 | 7.76 |
| 13 (female) | 87 | 61 | 163 | 2.10 | 3.02 | 11 | 22 | 7.49 |
| 14 (female) | 77 | 65 | 191.8 | 2.24 | 3.59 | 12 | 19 | 6.70 |
| 15 (female) | 86 | 59 | 120.6 | 3.24 | 3.03 | 10 | 15 | 9.63 |
| 16 (female) | 66 | 63 | 147 | 1.18 | 1.20 | 13 | 16 | 6.43 |
| 17 (female) | 81 | 60.5 | 130.2 | 2.23 | 2.11 | 15 | 13 | 9.35 |
| 18 (female) | 64 | 60.5 | 150.6 | 53.28 | 58.05 | 11 | 16 | 7.50 |
| 19 (female) | 75 | 61.5 | 148.6 | 2.32 | 3.17 | 9 | 10 | 8.52 |
| 20 (female) | 75 | 65.5 | 108.8 | 0.52 | 0.36 | 10 | 11 | 9.88 |
| 21 (male) | 83 | 63 | 145.2 | 1.19 | 2.41 | 12 | 14 | 7.59 |
| 22 (female) | 80 | 58 | 144.4 | 5.04 | 3.24 | 11 | 10 | 8.80 |
| 23 (female) | 67 | 62 | 176.4 | 16.73 | 25.90 | 13 | 8 | 5.47 |
| 24 (female) | 86 | 64.5 | 167.4 | 1.29 | 2.03 | 10 | 9 | 8.50 |
| 25 (male) | 75 | 60.5 | 118.6 | 14.31 | 11.94 | 12 | 14 | 8.69 |

| Exercise Group: Posttest Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Participants | Age (yrs) | Height (inches) | Weight (lbs) | 1-Legged Stance (Right Leg) (s) | 1-Legged Stance (Left Leg) (s) | 30 s Chair Stand (reps) | 30 s Arm Curls (reps) | 8-Foot Up-and-Go (s) |
| 1 (female) | 67 | 59 | 108.4 | 19.03 | 22.27 | 13 | 12 | 5.90 |
| 2 (female) | 77 | 60 | 161.6 | 8.12 | 10.62 | 19 | 20 | 6.32 |
| 3 (female) | 75 | 60 | 177.2 | 13.56 | 21.25 | 16 | 20 | 6.01 |
| 4 (female) | 77 | 57 | 135.4 | 27.27 | 7.94 | 26 | 23 | 6.67 |
| 5 (female) | 72 | 58 | 109.2 | 2.32 | 3.01 | 13 | 14 | 6.70 |
| 6 (female) | 66 | 63 | 127.8 | 92.24 | 77.35 | 15 | 16 | 4.81 |
| 7 (male) | 80 | 64 | 165.6 | 100.21 | 79.69 | 17 | 26 | 5.72 |
| 8 (male) | 77 | 66 | 152.8 | 41.56 | 19.06 | 13 | 15 | 6.13 |
| 9 (male) | 85 | 65 | 169.4 | 2.30 | 2.60 | 15 | 17 | 7.09 |
| 10 (male) | 61 | 67.5 | 147.4 | 180 | 180 | 35 | 48 | 2.53 |
| 11 (male) | 83 | 68 | 145.8 | 4.89 | 2.2 | 12 | 14 | 6.58 |
| 12 (female) | 68 | 62 | 184.6 | 22.27 | 18.32 | 12 | 17 | 6.83 |
| 13 (female) | 87 | 61 | 162 | 3.37 | 6.13 | 15 | 22 | 6.19 |
| 14 (female) | 77 | 65 | 194.6 | 1.57 | 1.24 | 8 | 18 | 6.19 |
| 15 (female) | 86 | 59 | 126.2 | 3.06 | 5.32 | 11 | 15 | 8.80 |
| 16 (female) | 66 | 63 | 144.8 | 3.27 | 4.14 | 15 | 16 | 5.81 |
| 17 (female) | 81 | 60.5 | 134 | 6.69 | 5.87 | 19 | 23 | 8.69 |
| 18 (female) | 64 | 60.5 | 153.8 | 8.06 | 17.12 | 13 | 19 | 6.56 |
| 19 (female) | 75 | 61.5 | 147 | 16.39 | 8.37 | 12 | 17 | 6.83 |
| 20 (female) | 75 | 65.5 | 107 | 17.20 | 11.88 | 11 | 22 | 6.10 |
| 21 (male) | 83 | 63 | 144.4 | 5.40 | 6.39 | 16 | 17 | 7.75 |
| 22 (female) | 80 | 58 | 144.7 | 9.44 | 6.69 | 12 | 14 | 7.26 |
| 23 (female) | Was not available for posttest | | | | | | | |
| 24 (female) | Was not available for posttest | | | | | | | |
| 25 (male) | Was not available for posttest | | | | | | | |

| Walking (Control) Group: Pretest Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Participants | Age (yrs) | Height (inches) | Weight (lbs) | 1-Legged Stance (Right Leg) (s) | 1-Legged Stance (Left Leg) (s) | 30 s Chair Stand (reps) | 30 s Arm Curls (reps) | 8-Foot Up-and-Go (s) |
| 1 (male) | 65 | 65 | 190.8 | 19.27 | 21.43 | 15 | 17 | 6.27 |
| 2 (female) | 68 | 61 | 154.6 | 25.09 | 27.17 | 12 | 16 | 6.79 |
| 3 (female) | 63 | 62 | 194.4 | 3.67 | 2.64 | 12 | 21 | 7.23 |
| 4 (female) | 67 | 62 | 122.4 | 15.45 | 13.95 | 11 | 13 | 6.63 |
| 5 (female) | 80 | 58 | 141.6 | 19.92 | 22.37 | 10 | 14 | 7.77 |
| 6 ( female) | 71 | 59.5 | 164 | 5.48 | 7.67 | 15 | 25 | 6.62 |
| 7 (female) | 82 | 61.5 | 138.8 | 5.84 | 5.29 | 10 | 22 | 6.99 |
| 8 (male) | 64 | 66 | 180.4 | 3.65 | 1.59 | 12 | 20 | 7.08 |
| 9 (female) | 66 | 57.5 | 155.2 | 8.40 | 9.34 | 11 | 18 | 8.29 |

| Walking (Control) Group: Posttest Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Participants | Age (yrs) | Height (inches) | Weight (lbs) | 1-Legged Stance (Right Leg) (s) | 1-Legged Stance (Left Leg) (s) | 30 s Chair Stand (reps) | 30 s Arm Curls (reps) | 8-Foot Up-and-Go (s) |
| 1 (male) | 65 | 65 | 194.2 | 29.98 | 40.41 | 17 | 29 | 4.34 |
| 2 (female) | 68 | 61 | 153.8 | 36.65 | 35.99 | 15 | 24 | 6.51 |
| 3 (female) | 63 | 62 | 190.7 | 13.12 | 10.6 | 14 | 28 | 6.99 |
| 4 (female) | 67 | 62 | 120.9 | 31.87 | 25.91 | 13 | 14 | 5.96 |
| 5 (female) | 80 | 58 | Did not participate in program | | | | | |
| 6 (female) | 71 | 59.5 | Did not participate in program | | | | | |
| 7 (female) | 82 | 61.5 | Did not participate in program | | | | | |
| 8 (male) | 64 | 66 | Did not participate in program | | | | | |
| 9 (female) | 66 | 57.5 | Did not participate in program | | | | | |