Improving Functional Abilities in Older Adults

Which are the most effective training programs for your mature clients, and how can you best assess their current level of functional ability?

By Cody Sipe, MS

The number of people now approaching middle age in America is simply astonishing—and unprecedented in history. It is anticipated that the U.S. population of adults over the age of 65 will more than double by the year 2030—reaching an estimated *71 million* people (U.S. Census Bureau 2004). According to the U.S. Department of Health and Human Services, approximately 27% of adults between the ages of 65 and 74 have difficulty with, or are unable to perform, at least one basic activity of daily living (National Center for Health Statistics [NCHS] 2006). That number climbs to 44% for adults aged 75 and older (NCHS 2006). In addition, it is estimated that 22%–53% of the older-adult population will develop **sarcopenia,** a significant loss of muscle mass and strength seen with advancing age and an independent risk factor for the development of disability (Iannuzzi-Sucich, Prestwood & Kenny 2002).

Obviously, the burgeoning older population represents a challenge for the fitness industry. Lack of physical activity is the cause of many of the physical challenges that older adults face. While it is important to get older adults moving as much as possible, it is equally vital that we train our clients so that they can achieve the best results in as safe and expedient a manner as possible. One way to ensure that you are on the right track with your older clients is to assess their functional capabilities, using correct methods and tools, before designing the clients' exercise programs.

Defining Function in Older Adults

Function can generally be defined as the ability to perform physical tasks. In older adults, functional ability can be quantified using a number of different tools, including paper and pencil questionnaires, field tests and laboratory tests. Selecting appropriate measurement tools for this older population can be challenging, since many of the tools available can have either a floor or ceiling effect, meaning that clients can perform higher or lower than the test will allow. Furthermore, because these measures vary so greatly among researchers who have investigated exercise and function, it is often difficult to make direct "apple to apple" comparisons between studies.

For a detailed look at some of the more prevalent assessment tools used to determine functional ability in this population, see "Common Measures for Assessing Function in Older Adults" sidebar.

Functional Categories of Older Adults

Prior to designing any exercise program, it is helpful to categorize older clients into functional categories. The "Hierarchy of Physical Function in Older Adults" sidebar provides a general framework to work from and allows fitness professionals to conceptualize the overall abilities of the whole person (Spirduso 2005). With advancing age and inactivity, the danger is that as clients experience physiological declines, they will also accumulate functional impairments and move down the hierarchy until they become physically disabled. Note in the sidebar at the bottom of the next page how a client's physical function can deteriorate from stellar to utterly dependent.

The "Disablement Pathway of Older Adults" sidebar indicates how functional abilities move along a disablement pathway, starting with minor impairments and ending with total disability. This process of disablement is central to the discussion on effective exercise interventions to improve function (Nagi 1965; Verbrugge & Jette 1994).

A Case Study in Disablement

So what does all this mean in the real world as you prepare to train your own older clients? Here's how the disablement pathway might affect an actual client of yours.

Martha is an 80-year-old woman who is unable to perform some daily activities, including opening the screw-type lid off of her favorite jar of pickles.

Opening the jar requires very little motor control, coordination, proprioception, balance or agility. Instead, the task requires muscle strength for grip and radial deviation. Does that mean that designing an exercise program for Martha that focuses on basic improvements in strength will improve her performance? The answer in this case is most likely yes, because the intervention would directly address the specific needs of the task.

However, Martha is also having significant difficulty with another daily task, which is putting on her slacks while standing; in fact, she has fallen several times in attempting this. It is more complicated than the first task, because it requires not only strength in multiple muscle groups (e.g., the buttocks, thigh, ankle and back) but also flexibility, coordination, proprioception and the integration of somatosensory input. So, what kind of exercise intervention will improve Martha's performance on this second, more complicated functional task?

While there are many types of interventions that could work in this scenario, the scientific body of research has proven the efficacy of three distinct exercise interventions for improving functional abilities in older-adult populations: traditional strength training, power training and functional-task training.

Disablement Pathway of Older Adults

Active Pathology: osteoarthritis, osteoporosis, diabetes, cardiovascular disease, fibromyalgia, chronic obstructive pulmonary disease (COPD) and cancer

Impairment: muscle weakness, low endurance, inflexibility, slowed reaction time and poor balance

Functional Limitation: grasping objects, transferring, walking, stepping up, standing, reaching or carrying objects

Disability: cooking, cleaning, bathing, dressing (fulfilling socially defined roles as mother, worker, volunteer, etc.)

Source: Nagi 1965.

Traditional Strength Training

The decline in muscle strength associated with aging has detrimental effects on physical functioning. A significant correlation has been found between muscle strength and a number of functional tasks (Bean et al. 2002). That's why so many of today's best trainers are using traditional **progressive resistance training** (RT), which is widely accepted as a primary intervention for improving function and quality of life in older adults—even the very old.

The efficacy of RT in building muscle mass and improving strength in adults as old as 90 has been well documented (American College of Sports Medicine [ACSM] 1998). For example, in a landmark study of nursing home residents, RT elicited leg strength improvements of 174% and increases in thigh muscle area of 9% on average (Fiatarone et al. 1990). RT has also been shown to improve other aspects of function in older subjects, including chair-rise time, stair-climb time and the 6-minute walk (Seynnes et al. 2004), along with dynamic balance and self-reported function (Sayers et al. 2003).

By contrast, a recent systematic review of the literature suggests that RT has only a small-to-moderate effect on function and that muscle strength increases do not necessarily translate to functional improvements (Latham et al. 2004). As part of this analysis, the authors compared 62 RT trials that met their specific inclusion criteria. They determined that, while RT showed a strong positive effect on strength, the effect on measures of function was varied. Specifically, the researchers reported a large improvement on chair-rise time, a modest effect on gait speed, and a nonsignificant effect on timed walk and timed up-and-go. No clear effect was found for measures of standing balance. Fourteen trials analyzed in this review reported disability outcomes, and there was no evidence that RT had an effect on physical disability. Other reviews have reported similar concerns regarding the abilities of RT to improve function (King, Rejeski & Buchner 1998; Keysor & Jette 2001).

Why the discrepancy between the significant functional benefits reported in the individual studies and the poor results from the comparative literature review? There may be many reasons, but an important factor to consider is the **heterogeneity,** or huge range of differences, within the older-adult population. Not all older adults experience functional losses from sarcopenia, but those who do tend to benefit the most from a traditional RT program. It is when muscle strength is the weak link in the functional chain that RT will have its greatest impact on function.

It should be noted that the Latham review included studies on subjects *regardless of their initial functional status.* As a result, the robustness of the functional benefits seen from RT for older or less functional individuals could be watered down. The Latham review does raise an interesting issue, however. Is RT the most effective intervention for *all* older adults, or only for those who experience functional declines directly related to sarcopenia?

Hierarchy of Physical Function in Older Adults

Elite: sports competition, senior Olympics, high-risk and power sports

Physically Fit: moderate physical work, all endurance sports and games, most hobbies

Independent: very light physical work, hobbies, low physical demand activities (golf, social dance, traveling); can pass all instrumental activities of daily living (IADL) (e.g., climbing stairs, shopping, doing housework, etc.)

Frail: light housekeeping, food preparation, grocery shopping; can pass some IADL, all basic activities of daily living (BADL) (walking, bathing, dressing, eating, transferring)

Dependent: cannot pass some or all BADL; needs home or institutional care

Source: Spirduso 2005.

Power Training

Power training—also referred to as **high-velocity training** or **explosive resistance training**—for older adults is starting to become a topic of many research studies. As with any new area of research and discussion, trainers must first understand the principle of power before ever applying it to clients.

Simply put, **power** is the product of force and velocity. Specifically, muscle power is the product of the force generated by the muscle and the velocity at which the contraction is performed. In other words, power is the rate (speed) at which force is generated. For example, if your client John can perform a submaximal repetition more quickly than Brian when each has the same workload, then John is generating more power than Brian because John is generating more velocity.

Because sarcopenia results in the preferential atrophy of type 2 (fast-twitch) muscle fibers, the remaining muscle mass is smaller, weaker and slower. This, in turn, has a dramatic impact on potential power generation. In fact, the power output of type 2 muscle fibers is approximately four times that of type 1 muscle fibers. Cross-sectional studies confirm this by reporting that muscle power declines earlier and more precipitously than either strength or velocity with advancing age (Metter et al. 1997). For example, if a client's strength and velocity both decrease by 30% (a realistic possibility), then power will be reduced by 51% (0.7 x 0.7 = 0.49)!

At extremely low forces (% 1RM), contractile velocity is maximized. That is, the body can perform movements much more quickly when using lower-resistance loads. As the percentage of 1RM increases, the maximal velocity of the muscle decreases in a rather linear fashion. Once the force capabilities of the muscle are exceeded, velocity—and therefore power output—drops to zero. In older adults it appears that peak power is achieved roughly around 60%–70% of 1RM; that is my own interpretation derived from numerous studies researched for this article that cited anywhere from 50%–80%.

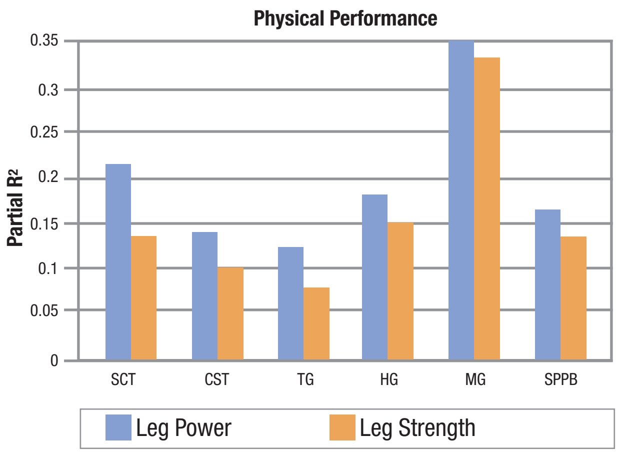
The majority of research studies measure muscle power using computerized pneumatic resistance equipment. After 1RM is assessed, subjects typically perform repetitions at set submaximal percentages such as 40%, 50%, 60%, 70% and 80%. Subjects are asked to perform the concentric portion of the movement as quickly as possible, then pause before performing the eccentric portion of the move in a slow and controlled manner. They are usually given anywhere from 30 seconds to 2 minutes of rest before performing the next repetition. The computer records the velocity of the movement, along with the resistance, to compute peak and average power. However, a number of field tests are currently being developed to estimate power *without* the need for this expensive computerized equipment.

By way of example, a recent study attempted to determine the optimal load for increasing muscle power in older adults (de Vos et al. 2005). Researchers randomly assigned 112 older adults to explosive resistance training at 20%, 50% or 80% of 1RM for 8–12 weeks or to a nontraining control group. Although average peak power improved similarly in all three of the training groups, average strength and endurance improved to a greater degree in the higher-load groups (de Vos et al. 2005). This led the researchers to conclude that, while muscle power can be improved similarly regardless of load, there is a dose-response relationship between load and improvements in strength or endurance. Interestingly enough, a follow-up study found that balance improved to a greater degree in the *lowest-load* group, whose strength and endurance improved the least (Orr et al. 2006).

The relationship between muscle power and physical functioning has been well documented (Bassey et al. 1992; Earles, Judge & Gunnarsson 1997; Foldvari et al. 2000; Bean et al. 2002). In fact, research on older adults has consistently shown that muscle power is more important than strength when it comes to improving many functional abilities, such as stair-climb time, chair-rise time, maximal walking speed, 8-feet up-and-go time and the Short Physical Performance Battery (see "Common Measures for Assessing Function in Older Adults"sidebar for an explanation of terms). Comparison studies of power and strength training indicate that while both can increase strength, older adults typically have larger gains in power with power training (Signorile et al. 2005). And while few randomized, controlled trials have directly compared the two training methods, a growing body of evidence suggests that power training may improve functional abilities in older adults more than traditional low-velocity strength training, especially for lower-functioning subjects (Fielding et al. 2002; Hruda, Hicks & McCartney 2003; Miszko et al. 2003). See Figure 1 on page 56 for evidence that power has a closer relation to physical function than does strength.

Although power training shows great promise for older adults, the optimal training regimen has yet to be determined. The volume of scientific literature on the topic is still relatively small, and most of the studies that do exist used a wide variety of protocols, including the use of pneumatic resistance machines, body weight, resistance bands and weighted vests. Additional dif-

Figure 1. The Relationship Between Power and Physical Performance

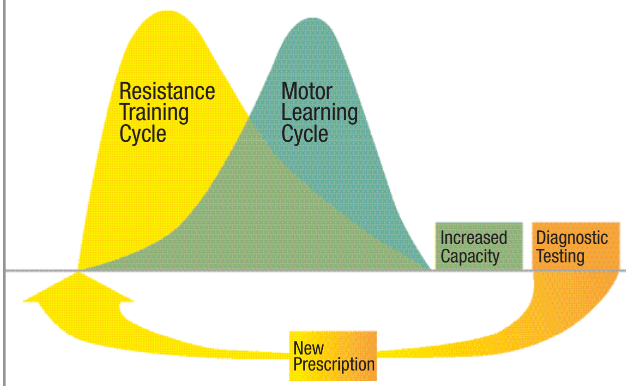


SCT = stair-climb time
CST = chair stand time
TG = tandem gait
HG = habitual gait
MG = maximal gait
SPPB = Short Physical Performance Battery

Note: R squared is a statistical measure from 0 to 1 that represents the degree to which one variable predicts another. A value of 0 means that the two variables are completely unrelated, while a value of 1 means that the two variables are directly related to one another. So in this example, power is more closely related to physical function than strength is.

Source: Bean et al. 2002.

Figure 2. Periodization Model



Repeating pattern of physical-factor training, translational motor-skill training, adaptation, reevaluation and prescription modification in the periodization model.

Source: Signorile et al. 2005b. Reprinted with permission from the International Council on Active Aging.

ferences among these studies—in terms of length of intervention, training frequency, sets, reps, load, subject characteristics and outcomes—make it very difficult to determine a specific training program to optimize function in older adults.

Functional-Task Training

An argument could be made that if you want your older clients to improve their performance on a functional task, then you should have them practice that specific task. This is basically the approach that **functional-task training** programs take. Although functional-task training embraces some components of traditional resistance training and power training, it differs by focusing more on the replication of daily tasks; placing a greater emphasis on motor control and coordination; including a more robust use of whole-body movements; and using few, if any, isolated exercises that work only one muscle group at a time.

This kind of task training is a more direct approach to functional performance because of its underlying concept of specificity. Instead of working at the impairment level (see the "Disablement Pathway of Older Adults" sidebar) and hoping for improvements to "trickle down" to the functional level, the idea is to attempt to apply the principles of task specificity more directly at the functional level.

Take a recent study in which researchers observed the differential effect of functional-task exercise versus traditional resistance exercise on the functional abilities of 98 healthy women aged 70 and older; subjects in a nontraining control group were asked to maintain their usual pattern of activity (de Vreede et al. 2005). The resistance exercise group performed standard strengthening exercises for the upper and lower body using dumbbells and elastic tubing. The functional-task group performed exercises in the following domains: moving with a vertical component, moving with a horizontal component, carrying an object and alternating between lying, sitting and standing positions. The training instructors manipulated the motor, environment and cognitive aspects of the tasks, depending on participants' abilities. Both training groups exercised three times a week for 12 weeks. By the end of the study period, isometric knee extensor strength and isometric elbow flexor strength had improved more in the resistance group than in the functional-task group; leg extensor power had improved similarly in both training groups. However, functional ability improved significantly more in the functional-task group than in the resistance group, and this improvement was sustained for 6 months following the study. The authors concluded that functional-task exercise is more advantageous than

Common Measures for Assessing Function in Older Adults

The following tools are most frequently employed when assessing functional abilities in older clients.

Aggregate Performance Measures

- Short Physical Performance Battery: This test evaluates balance, gait, strength and endurance on ability to stand with feet together while positioned side to side and in semi-tandem and tandem positions, along with time to walk 8 feet and time to rise from a chair and return to a seated position five times; a summary performance score is created by totaling the performance ranking of each test.
- Continuous-Scale Physical Functional Performance Test: Designed to measure physical function, this instrument tests ability to perform separate physical domains of upper- and lower-body strength; flexibility; balance; coordination; and endurance. It tests ordinary ADL performed at maximal effort within the bounds of an older client's safety and comfort; the score is an average of the five different test scores.
- Senior Fitness Test Battery: This is a battery of six tasks (30-second chair stand, 8-feet up-and-go, modified sit-and-reach, back scratch, seated arm curl and either a 2-minute step-in-place or a 6-minute walk). Performance is compared against age and gender-specific "norm" tables.

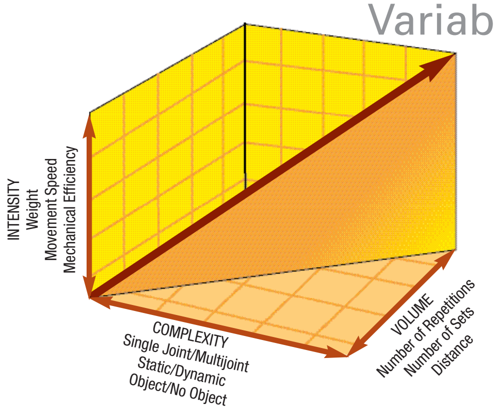
Single-Task Performance Measures

- Chair-Rise Time: the time required to rise to a standing position from a seated position without using arms for assistance
- 30-Second Chair Stands: the number of times a person can rise to a standing position from a seated position in 30 seconds without using arms for assistance
- Stair-Climb Time: the time required to ascend a flight of stairs
- 8-Feet Up-and-Go: the time required to rise from a seated position, walk around a cone 8 feet away and return to the seated position

Questionnaires

- Basic Activities of Daily Living (BADL): asks about difficulty with eating, dressing, bathing and mobility tasks
- Instrumental Activities of Daily Living (IADL): asks about difficulty walking several blocks, climbing stairs, doing housework, shopping, using public transportation and doing vigorous activities
- Late-Life Function and Disability Instrument: a 41-item questionnaire that assesses four domains: upper-body function, lower-body function, upper-body disability and lower-body disability

Figure 3. Translational Cycle Variables



During a typical translational cycle, the variables of intensity, complexity and volume are manipulated to progress from the resistance training cycle to the motor learning cycle.

Source: Signorile et al. 2005b. Reprinted with permission from the International Council on Active Aging.

resistance exercise for older adults, most likely owing to the principle of training specificity, given the "complex interplay of cognitive, perceptual and motor functions that are involved in the performance of daily tasks" (de Vreede et al. 2005).

The Future of Translational Training

One noted researcher, Professor Joseph Signorile, PhD, at the University of Miami, is at the forefront of an emerging area of research that focuses on the use of periodization to maximize function in older adults. Termed **translational training,** this approach uses cycles of hypertrophy, strength and translational periods to improve activities of daily living (ADL) performance (Signorile 2005a). As training volume and then intensity taper off, ADL-based skill training is incorporated. Using this approach, resistance and motor-skill training are incorporated into a program that manipulates volume, intensity and complexity in a systematic manner according to the older client's individual needs (Signorile 2005b). See Figures 2 and 3.

Exercises to increase complexity include ladder drills, line drills, chair drills, transferring objects and combination movements. While this novel model has not been fully investigated or compared with other forms of training, it does represent a promising area of scientific inquiry, and it is an example of the direction in which the research is moving.

Drawing Conclusions

Exercise offers many benefits for the health, function and quality of life of our older clients. The trouble is, we still don't fully understand all of the specific components of what would constitute the optimal program to improve and maintain function into late life. However, we can be certain of one thing: physical inactivity, and not necessarily the aging process itself, is the cause of many of the detrimental changes that individuals experience as they grow older.

It is therefore imperative that the fitness industry do everything it can to entice older adults to exercise and train in some way, shape or form. However, it is also vital that we train older people so they can achieve maximum results with minimum investment in the safest manner possible. Trainers must choose which methods they feel they are competent enough to use effectively and safely.

Although progressive resistance training is well understood by most trainers, power training and functional-task training are much less well understood, and there are currently no established or accepted training guidelines to govern their use.

Therefore, power training and functional-task training should only be used with older clients by trainers who can utilize these techniques safely and effectively while focusing on each client's individual health conditions and physical limitations.

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