

Functional Aging And Exercise

Learning Objectives

1. Describe the Hierarchy of Physical Function
2. Describe the Nagi Model of Disablement
3. List the components of function
4. Recall aerobic exercise guidelines for older adults and how to monitor intensity

Understanding Function

The functional capabilities vary significantly within the mature population which is significantly heterogeneous. An individual's chronological age is only a rough guideline as to their functional age (i.e. their capabilities). Although functional capacity generally decreases with advancing age the degree and rate of decline are highly variable so that individuals of the same age can exhibit highly variable levels of function ranging from the physically dependent to elite athletes. Therefore, an 80 year old may be able to outperform someone 10 or 20 years younger. Dr. Waneen Spirduso described five functional categories of older adults [10] that are helpful to understanding the heterogeneity that exists within this group of individuals.

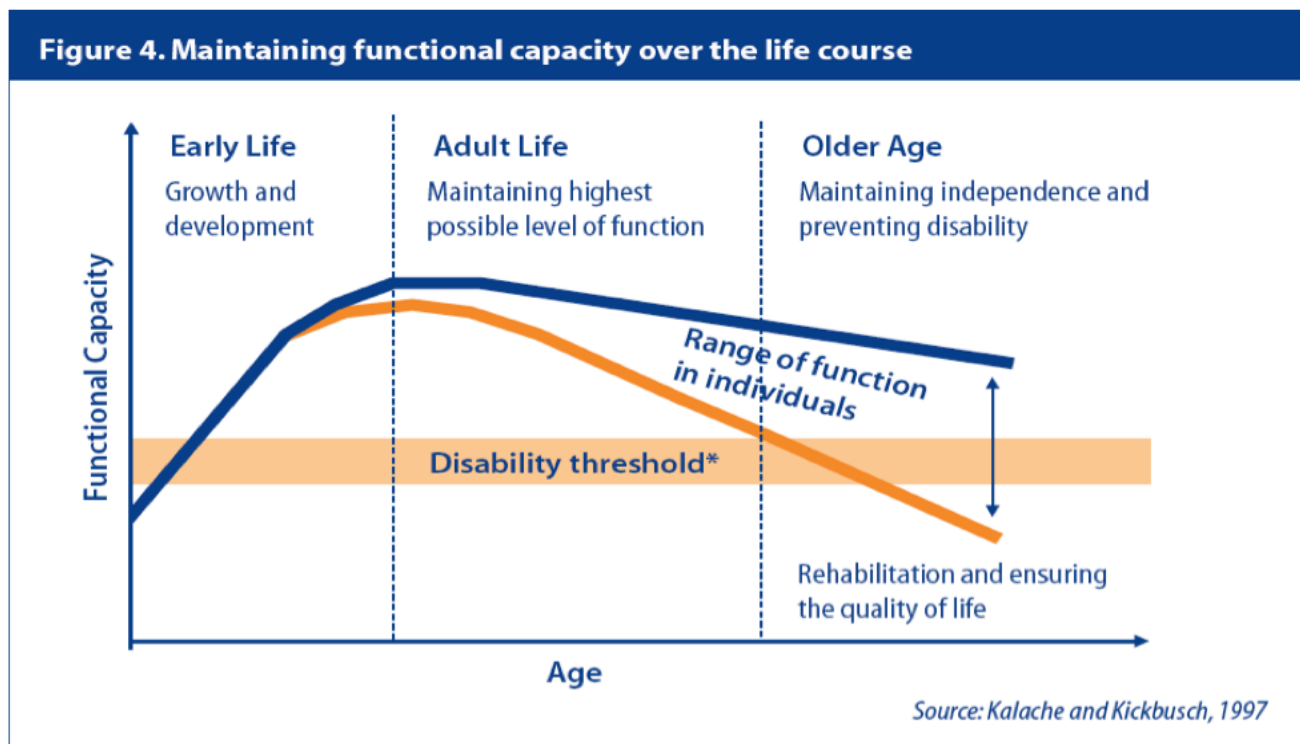
1. **Elite:** The physically elite have achieved the highest level of physical function and are often more fit than sedentary individuals that are decades younger. They train rather intensely on a daily basis and typically compete in tournaments with others their age such as Senior Olympics, Masters tournaments or in other general events. Due to their high levels of activity (and usually excellent dietary habits) they are also in excellent health.
2. **Physically fit:** Fit older adults exercise primarily for their health and well-being rather than for competition and do so anywhere from 2-7 times per week. Their exercise program is less intense and of shorter duration than the physically elite. They enjoy higher than average levels of health and are typically estimated to be much younger than their chronological age by their peers.

3. **Independent:** These individuals do not exercise but may be physically active. They are typically of average health and without any serious debilitating disease. However, since they do not focus as much on health then they are also at increased risk of disease and often possess multiple chronic disease risk factors. They have few functional limitations but are at higher risk of frailty and disability due to a reduction in physiologic reserve capacity.
4. **Frail:** According to Campbell and Buchner [15] frailty is a “condition or syndrome that results from a multi-system reduction in reserve capacity to the extent that a number of physiological systems are close to, or past, the threshold of symptomatic clinical failure. As a consequence the frail person is at increased risk of disability and death from minor external stresses”. Frail older adults can perform activities of daily living (ADLs) such as bathing, dressing, transferring, toileting and feeding although they have a debilitating disease or condition. Due to their physical challenges they may be unable to perform all of the instrumental activities of daily living (IADLs) such as shopping, doing laundry, preparing meals and doing light housework.
5. **Dependent:** These individuals are unable to perform all of the ADLs and are dependent on others and/or physical aids (e.g. canes, walkers, wheelchairs) to complete their daily tasks. The extent of their physical disability is determined by the degree to which they cannot perform ADLs and IADLs. Disability rates increase with chronological age and are higher in females, African Americans and the poor. Individuals can move in and out of disablement such as following

a stroke (where function is lost) and during rehabilitation (where function is often regained).

While it is easier to simply classify individuals into one category or another the truth is that these categories represent a continuum of functional capacity. Individuals may move back and forth between them depending on their current situation. For example, a physically fit individual who exercises regularly may experience some health problems or family issues that prevent him/her from training for an extended period of time. The lack of physical activity leads to a detraining effect so that they would now be considered independent rather than physically fit. The reverse could also happen in which an independent individual trains vigorously to move up to the physically fit or even elite categories. It is helpful to recognize where individuals are on this continuum but maybe even more important to understand their aging trajectory, that is, in which direction they are heading and how rapidly (Figure 3). As people get older the tendency is to decline in functional ability (a downward trajectory) due to the effects of primary and secondary aging. The downward trajectory can be exacerbated by disease processes. If functional capacity declines to the point to where the individual can no longer fulfill their socially defined roles such as employee, caretaker or volunteer, then they are considered to be physically disabled.

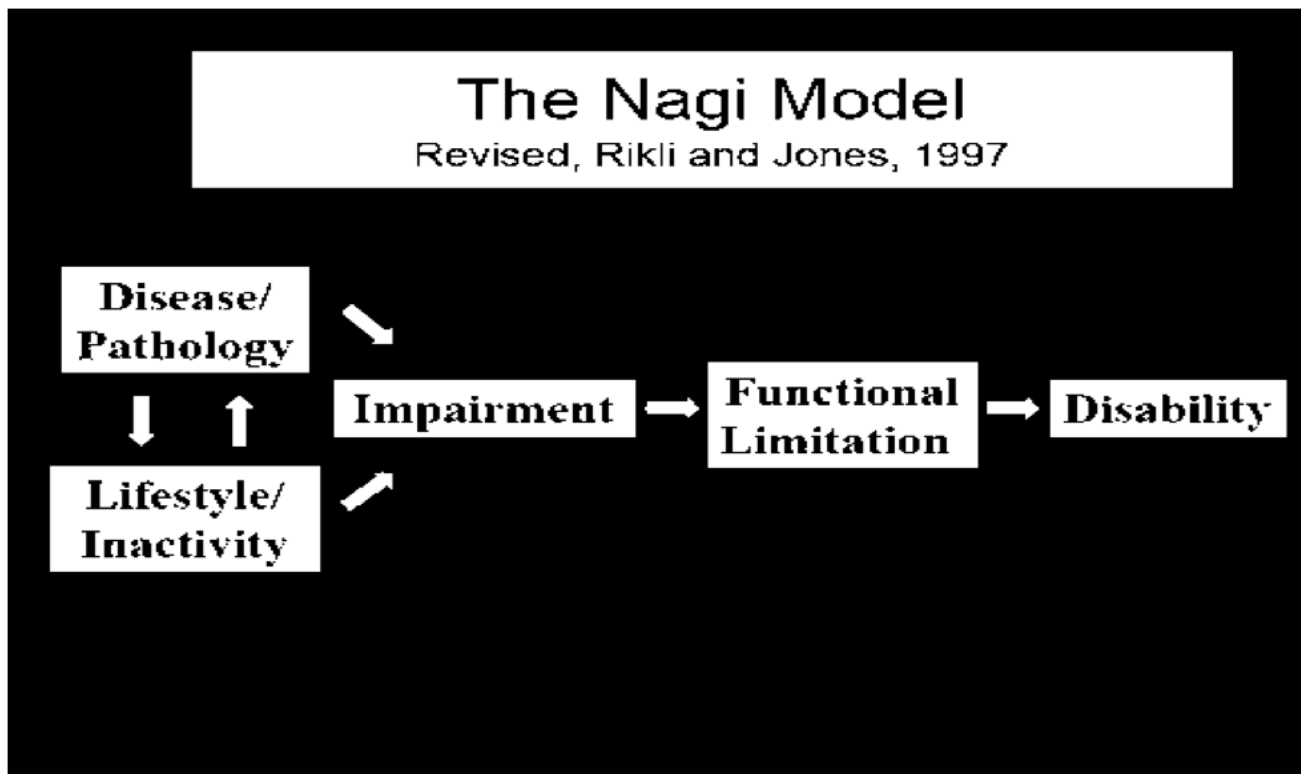
Figure 3: Trajectories of Aging



The pathway to disablement was first described by sociologist Saad Nagi in 1965 [16] and has been expanded upon by many others since (Figure 3). Understanding this basic pathway can help fitness professionals develop a more effective approach to training. The steps in the pathway are active pathology and/or physical inactivity, impairments, functional limitations and disability. Over time, diseases such as diabetes, cardiovascular disease, cancer and osteoporosis can lead to physical impairments such as muscle weakness, poor cardiorespiratory endurance, inflexibility and poor reaction time. Depending on the specific pathology or mix of pathologies these impairments may be a direct result of the disease processes or may be indirectly due to lower levels of physical activity. Diseased individuals often have lower levels of activity which can

exacerbate the disease process and can also lead to the impairments mentioned above. Even in the absence of disease physical inactivity can lead to impairments with advancing age. As impairments accumulate or worsen, then eventually the individual will experience limitations in their functional capabilities such as grasping objects, walking, stair climbing and carrying objects. If these limitations become severe enough the individual could lose their ability to perform duties that are essential to their socially defined roles (e.g. caretaker, employee, volunteer) and would then require assistance to perform these chores. Assistance could come from children, friends, social workers or medical personnel. At this point an individual would be considered disabled.

Figure 4: The Modified Nagi Model of Disablement



Exercise programs have shown modest success in improving functional capacity and delaying or avoiding disability in older adults with existing impairments and there is no clear optimal exercise program design [17, 18]. Exercise has been consistently found to positively affect impairment-level factors such as muscle strength, muscle power, muscular endurance, cardiorespiratory endurance, flexibility, joint range of motion and balance. However, the evidence for the beneficial effects of exercise on functional limitations is less clear. This is likely due to the wide variety of subject characteristics (age, gender, functional capabilities, disease processes) and exercise designs employed (frequency, intensity, type) as well as the lack of specificity between the training intervention and the functional outcomes being assessed.

Recent reviews have indicated that while exercise interventions may improve impairment level factors significantly this does not always lead to similar gains in functional capacity. In addition, subjects who experience the greatest gains in impairment level factors do not always experience the greatest gains in function. For example, an individual that performs a traditional progressive resistance strength program will significantly increase their strength but may only increase their ability to climb stairs, get out of a chair or carry objects by a small amount. While muscular strength is an important component necessary for performing these tasks it is not the only component. Function depends on a myriad of physiological components such as those listed below.

Components critical to physical function in older adults

- Muscular Strength
 - Isometric
 - Concentric
 - Eccentric
- Muscular Endurance
- Muscular Power
- Muscular Flexibility
- Joint Range of Motion
- Cardiorespiratory Endurance
- Proprioception
- Coordination
- Motor Control
- Reaction Time
- Balance
- Stability
- Postural Control
 - Anticipatory
 - Reactive

Recent evidence suggests that exercise interventions that challenge multiple components of function may lead to better functional improvements than programs

that focus on a single component [12, 19, 20]. These techniques will be explored in more detail in other modules.

Exercise Training

It's never too late to start. The evidence strongly demonstrates that regular exercise can improve health and fitness for adults of all ages and even after years of sedentary and unhealthy behaviors. Training studies with individuals in their 90s and beyond have demonstrated significant (statistically and/or practically) improvements in aerobic power, muscle strength, muscle power, flexibility, balance, physical function and many aspects of health. However, for many of these areas the optimal exercise prescription has yet to be identified due to current limitations in the research.

Aerobic Exercise

Mature adults engage in less physical activity than their younger counterparts. Aerobic exercise has been shown to be safe and beneficial for adults of all ages. By engaging in regular aerobic exercise mature adults can decrease their risk of chronic diseases; manage their current diseases better; and increase aerobic exercise capacity [7]. Exercise should be of sufficient intensity ($> 60\%$ $\text{VO}_{2\text{max}}$), frequency (> 3 days/wk) and duration (> 20 min) to elicit cardiovascular and health adaptations. Individuals without significant health risks or conditions can participate in more vigorous exercise and sports activity such as basketball or running. The mode of aerobic exercise is an

Figure 5: The Borg Scale

Rating of Perceived Exertion Borg RPE Scale		
6	Very, very light Very light Fairly light	How you feel when lying in bed or sitting in a chair relaxed. Little or no effort.
7		
8		
9		
10		
11		
12	Somewhat hard Hard	Target range: How you should feel with exercise or activity.
13		
14		
15		
16		
17	Very hard Very, very hard Maximum exertion	How you felt with the hardest work you have ever done.
18		
19		
20		
		Don't work this hard!

important consideration and depends on the individual's orthopedic conditions, goals and exercise history. Those with significant arthritis of the knees, hips or spine; joint replacements; osteoporosis and other orthopedic conditions should avoid high-impact exercises such as jogging and instead should engage in low or non-impact exercises such as bicycling or swimming. This includes cardiovascular equipment such as an upright bike, recumbent bike, recumbent stepper, treadmill, elliptical trainer and rower. Clients with a history of falling or with balance deficits should avoid activities with an increased risk of falling such as skiing, horseback riding or skating.

Typical techniques to monitor exercise intensity such as heart rate and the “talk test” can still be used with mature clients. However, it is also useful to use rating of perceived exertion (RPE) in order to gauge intensity especially if the client is taking medications that suppress heart rate such as beta blockers. An RPE of 12-13 on the Borg 6-20 scale (figure 5) corresponds to moderate intensity aerobic exercise. RPE is often an easier tool for older clients to use when heart rate monitors are unavailable and counting a pulse rate is difficult. Maximal heart rate is typically calculated as $220 - \text{age}$ but more recent information indicates that a more accurate equation for determining maximal heart rate is $208 - (0.7 \times \text{age})$ in healthy adults over the age of 40 [22]. The original formula tends to overestimate maximal heart rate in younger populations and underestimate them for older populations. Target heart rate should be calculated using either the direct or heart rate reserve methods according to the intensity desired. Although moderate-intensity exercise is generally recommended, the individual’s health conditions and fitness status will determine the appropriate level of intensity that is both safe and effective. Many mature clients will be able to perform high-intensity interval training.

Resistance Exercise

Following traditional progressive resistance training the muscular strength of older adults can increase anywhere from 25% to more than 100% depending on the exercise program being used, the duration of the training, age and gender of the client, and the specific muscle groups being trained [7]. Muscle power also increases follow-

ing resistance exercise training although evidence suggests that high-velocity training protocols may improve muscle power to a greater degree [23, 24]. It is recommended that mature adults engage in at least 2 days per week of moderate intensity strength training that includes 8-10 exercises involving the major muscle groups of 1-3 sets of 8-12 repetitions each [7].

Mature adults can safely and effectively use a wide variety of resistance training methods and equipment such as resistance machines, resistance bands, free weights, body weight, hydraulic and pneumatic equipment. Equipment selection is dependent on the individual's capabilities and goals. Each has its advantages and disadvantages. It is a misconception that mature adults should only use light dumbbells or easy resistance bands because they might become injured. The muscles of older adults need to be challenged in order to grow just as the muscles of younger adults do and although this population has more orthopedic concerns than younger populations resistance exercise has been shown to be generally safe.

However, resistance exercise techniques for mature adults need to go beyond these basic recommendations. As you will learn there are many limitations to the traditional strength exercise approach. The Functional Aging Training™ model described later is an approach to resistance exercise that addresses the numerous and diverse functional needs of the mature adult.