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وبینار سالمندی
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مرجعیت علمی

EXERCISE AND PHYSICAL ACTIVITY FOR OLDER ADULTS

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Table 4-1
Sections of the American Physical Therapy Association

17section

Section	Area(s) of Interest	Publication(s)
Acute Care	Physical therapy practitioners working with patients with acute care needs across the life span	<i>Journal of Acute Care Physical Therapy</i>
Aquatic Physical Therapy	Advance the practice of aquatic physical therapy	<i>Journal of Aquatic Physical Therapy</i>
Cardiovascular & Pulmonary	Development, application, and advancement of cardiovascular and pulmonary physical therapy practice, education, and research	<i>Cardiopulmonary Physical Therapy Journal</i>
Clinical Electrophysiology and Wound Management	Electrotherapy and physical agents, electrophysiologic evaluation, physical agents, and wound management SIG: Electrophysiologic Evaluation; Physical Agent Interventions: Electrotherapy, Thermotherapy, Light Therapy; and Wound Management	<i>Clinical Electrophysiology and Wound Management</i>
Education	Developing new practitioners, academic educators, educational leaders, and administrators SIGs: Academic Faculty, PTA Educators, and Clinical Educators	<i>Journal of Physical Therapy Education</i>
Federal Physical Therapy	High-quality physical therapy within federal medical services	e-Newsletter
Geriatrics	Clinical excellence of PTs and PTAs working with older adults SIGs: Balance and Falls, Health Promotion and Wellness, and Osteoporosis	<i>Journal of Geriatric Physical Therapy</i>
Hand Rehabilitation Health Policy & Administration	Hand and upper extremity rehabilitation Leadership development, health policy and administration SIGs: Cross-Cultural and International, Technology	<i>Hand Prints</i> <i>The HPA Resource, HPA Journal</i>
Home Health	Practice in home health care and other "out-of-hospital" settings	<i>Quarterly Report</i>

Table 4-1
Sections of the American Physical Therapy Association—cont'd

Section	Area(s) of Interest	Publication(s)
Neurology	Evidence-based practice, education, and research in neurologic physical therapy SIGs: Brain Injury, Degenerative Diseases, Spinal Cord Injury, Stroke, Balance and Falls, and Vestibular Rehabilitation	<i>Journal of Neurologic Physical Therapy</i>
Oncology	Physical therapy for individuals diagnosed with cancer or HIV or AIDS SIG: HIV/AIDS, Palliative and Hospice Care, and Lymphedema	<i>Rehabilitation Oncology</i>
Orthopaedic	Management of patients with musculoskeletal disorders SIGs: Occupational Health, Foot and Ankle, Performing Arts, Pain Management, and Animal Rehabilitation	<i>Journal of Orthopaedic and Sports Physical Therapy</i> <i>Orthopaedic Physical Therapy Practice</i>
Pediatrics	Highest quality of life for all children and people with developmental disabilities and their families	<i>Pediatric Physical Therapy</i>
Private Practice	Growth, economic viability, and business success of PT-owned physical therapy services	<i>Impact</i>
Research	Fosters and enhances physical therapy-related research SIG: Qualitative Research	<i>Section on Research Newsletter</i>
Sports Physical Therapy	Athletic injury management, including acute care, treatment and rehabilitation, prevention, and education	<i>Journal of Orthopaedic and Sports Physical Therapy</i> <i>North American Journal of Sports Physical Therapy</i>
Women's Health	Women's health across the life span	<i>Journal of the Section on Women's Health</i> <i>Highlights in Women's Health</i>

BOX 4-5 Approved Specialty Areas in Physical Therapy 8

- Cardiovascular and Pulmonary
- Clinical Electrophysiologic
- Geriatric
- Neurologic
- Orthopaedic
- Pediatric
- Sports
- Women's Health



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Guccione's Geriatric Physical Therapy

FOURTH EDITION

Guccione's Geriatric Physical Therapy

FOURTH EDITION

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OUTLINE

- Introduction
- Physical Activity
- Physical Stress Theory
- General Indications and Precautions
- Blood Glucose
- Pain
- **Elements of an Exercise Prescription**
- Specificity
- Progressive Overload
- Reversibility
- Endurance
- Neuromuscular Training
- Enjoyment and Value

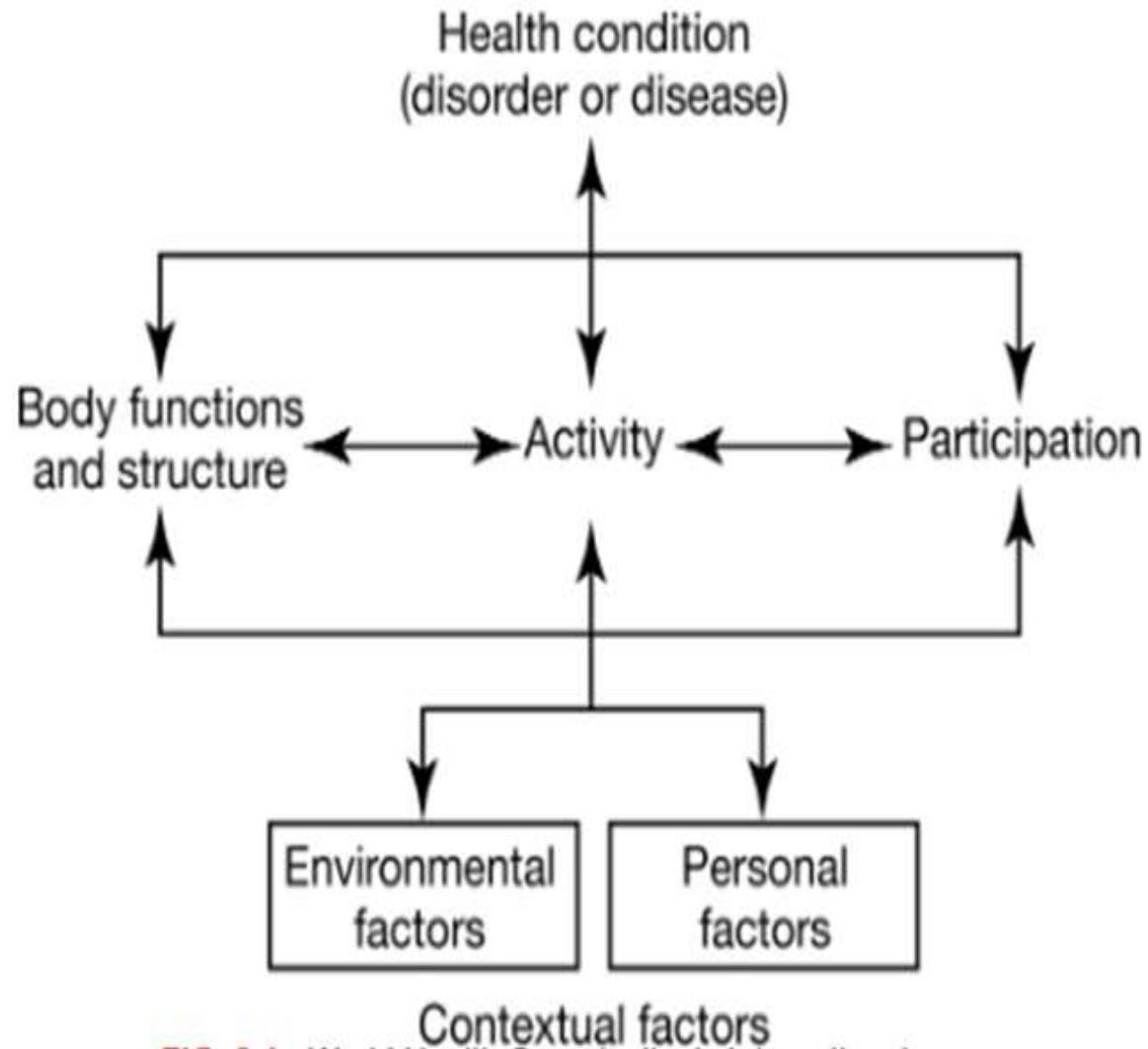
- **Application of Principles to Exercise Types**
- Aerobic Exercise
- Aquatic Exercise
- Resistance Training
- *Core Stability*
- Speed, Power, and Plyometrics
- Functional Training and Multicomponent Programs
- Flexibility and Joint Mobility
- *Yoga*
- *Proprioceptive Neuromuscular Facilitation*
- Balance Training and Fall Prevention
- **Safety**

INTRODUCTION

- Exercise is known to simultaneously impact and mediate chronic disease, many impairments, functional deficits, quality of life, falls, and cognition, and prevent the negative sequelae associated with sedentary lifestyles.
- Combined with regular physical activity, appropriately prescribed exercise is the mainstay of the geriatric physical therapists' toolbox of interventions.
- Although many principles of exercise have been known for decades, their application to older adults is relatively recent.
- The central role of physical activity and exercise is illustrated in the World Health Organization's (WHO) International Classification of Functioning, Disability, and Health



World Health Organization's International Classification of Functioning, Disability, and Health (ICF)



Box 8.1

Definition of Terms Related to Physical Activity and Exercise

Term	Definition	Notes
Physical activity	Any self-imposed bodily movement that results in a substantial increase in caloric requirements over resting energy expenditure	Defined by MET level
Exercise	Planned, structured, deliberate physical activity done to improve and/or maintain one or more components of physical fitness	Classified by mode, such as aerobic, resistance, flexibility, and plyometric
Physical fitness	The ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and respond to emergencies ²¹⁴	Cardiovascular fitness, classified by VO_2 max Strength fitness: capacity of the skeletal muscle to move an external load; classified as repetition maximum Balance fitness: ability to control the body's position throughout movement Flexibility fitness: ability to achieve an extended range of motion
Physical inactivity	Physical activity levels less than those required for optimal health and prevention of premature death ²¹⁴	

- Many aging adults are able to maintain a very high, active lifestyle that includes tennis, skiing, hiking, biking, and running well into late life with little to no disability.
- Achieving 150 minutes per week of moderate-intense aerobic exercise is associated with at least a 30% lower risk of morbidity, mortality, and functional dependence compared with being inactive.
- Walking 5 to 7 days per week was associated with a 50% to 80% lower risk of mobility impairments, increased longevity by around 4 years, and disability-free life expectancy by around 2 years.



BENEFITS OF PHYSICAL ACTIVITY FOR OLDER ADULTS

Strong Evidence

- ⇒ Lower risk of early death
- ⇒ Lower risk of coronary heart disease
- ⇒ Lower risk of stroke
- ⇒ Lower risk of high blood pressure
- ⇒ Lower risk of adverse blood lipid profile
- ⇒ Lower risk of type 2 diabetes
- ⇒ Lower risk of metabolic syndrome
- ⇒ Lower risk of breast cancer
- ⇒ Weight loss, particularly when combined with reduced calorie
- ⇒ Visceral fat loss, even in the absence of overall weight loss
- ⇒ Improved cardiorespiratory and muscular fitness
- ⇒ Improves urinary incontinence through pelvic floor strengthening
- ⇒ Improves balance and agility, thus mediating fall risk and fractures
- ⇒ Decreased pain, especially from osteoarthritis
- ⇒ Reduced depression and improved mental health
- ⇒ Better cognitive function

Moderate to Strong Evidence

- ⇒ Better functional performance in ADLs and IADLs
- ⇒ Reduced abdominal obesity
- ⇒ Prevention of weight gain during menopause and beyond
- **Moderate Evidence**
- ⇒ Lower risk of hip fracture
- ⇒ Lower risk of lung cancer
- ⇒ Lower risk of endometrial cancer
- ⇒ Weight maintenance after weight loss
- ⇒ Increased bone density
- ⇒ Improved sleep quality



THE IMMUNE SYSTEM

- It is now evident that with **advancing age**, there is **an increase in systemic inflammation** because of changes in **the immune system**.
- Major increases in known **proinflammatory cytokines** such as **interleukin 1, 6, and 10 (IL-1, IL-6, IL-10)**; **C-reactive protein (CRP)**; and **tumor necrosis factor- α (TNF- α)** occur with advancing age, which is **significantly associated** with
 1. muscle wasting,
 2. obesity,
 3. loss of physical function.^{5,7,17,56,57,120,121}
- Not only do increased inflammatory cytokines result in muscle wasting, but also they **diminish the function of other organ systems**, which **reduces reserve and shrinks the window of homeostasis**. The **increase in inflammatory cytokines** is also **associated with metabolic syndrome**, which is a major risk factor for CVD.
- **The increase in systemic inflammation** is also an underlying factor in the development of **age-related diseases** such as **Alzheimer disease**, **atherosclerosis**, **cancer**, and **diabetes**.^{18,120,123}
- Thus, it is hypothesized that **controlling inflammatory** status may allow for **more successful aging**.



- Four main approaches to the management of increased systemic inflammation have been considered:
 1. anti-inflammatory drugs,
 2. use of antioxidants through diet,
 3. caloric restriction,
 4. exercise
- Exercise is far superior to the minimal impact noted from anti-inflammatory drugs and antioxidants.^{18,126,127} One exercise bout results in a significant reduction in markers of inflammation such as IL-1, IL-6, and TNF- α and an increase in brain-derived neurotrophic factor (BDNF).^{121,123,126}
- Because visceral fat secretes proinflammatory cytokines such as IL-1, IL-6, IL-10, CRP, and TNF- α , consistent physical activity can help reduce visceral fat accumulation, thereby reducing the inflammatory process, which impacts bone, muscle, and cardiovascular health.

- A prospective study of 19,000 participants in the Cooper Institute Aerobic Center in Dallas, Texas, found that higher midlife fitness levels were associated with lower hazards of developing all-cause dementia later in life (70 to 85 years old).
- These current findings suggest that physical therapy can play an important role in the management of systemic inflammation, enhancing systemic “reserve,” reducing risk for disease, and delaying functional decline through the use of exercise.



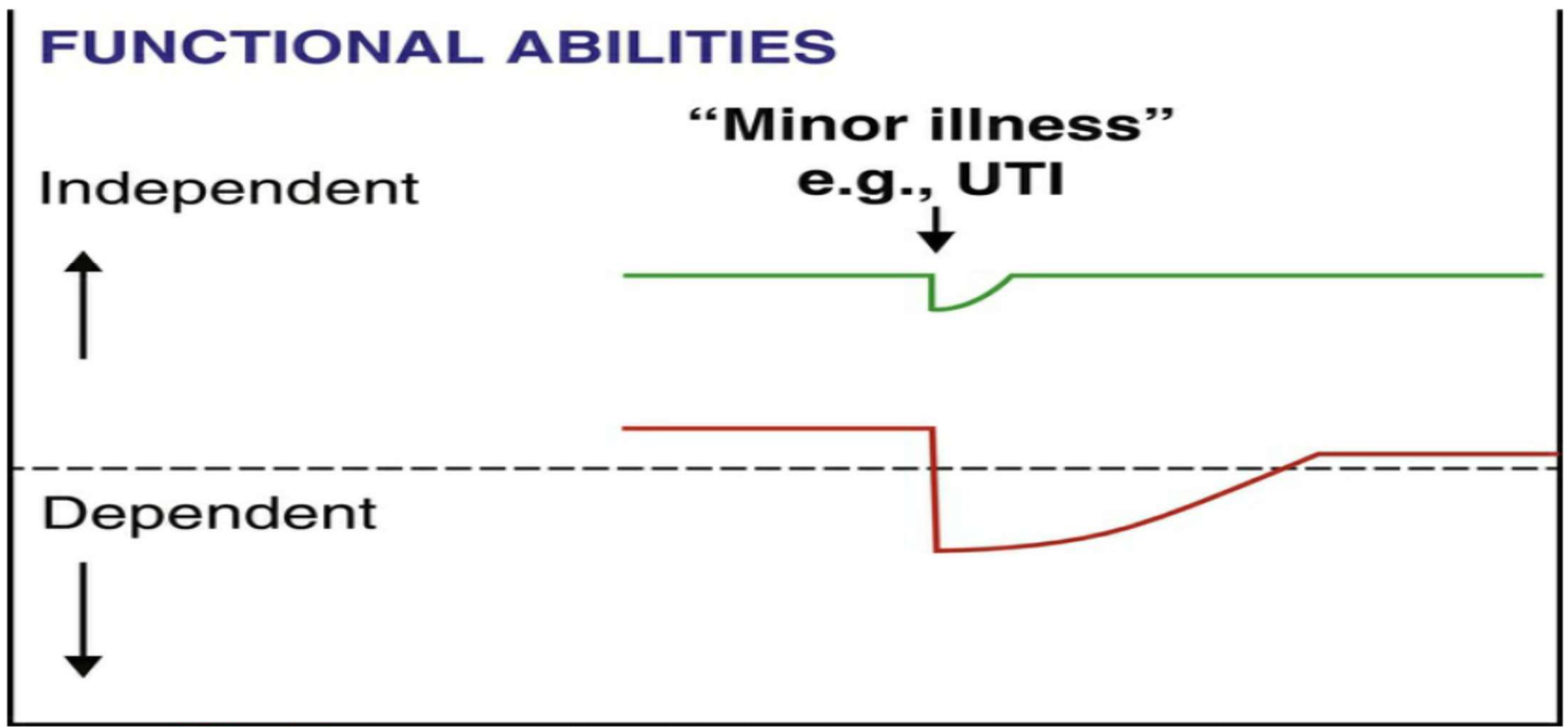


FIG. 1.4 Vulnerability of frail older people to a sudden change in health status following a minor illness. The green line represents a fit older person who, following a minor stress such as an infection, experiences a relatively small deterioration in function and then returns to homeostasis. The red line represents a frail older person who, following a similar stress, experiences a larger deterioration that may manifest as functional dependency and who does not return to baseline homeostasis. *UTI*, urinary tract infection. Reprinted with permission from Elsevier (Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. *The Lancet*. 2013;381(9868):752-762).

Skeletal Tissue

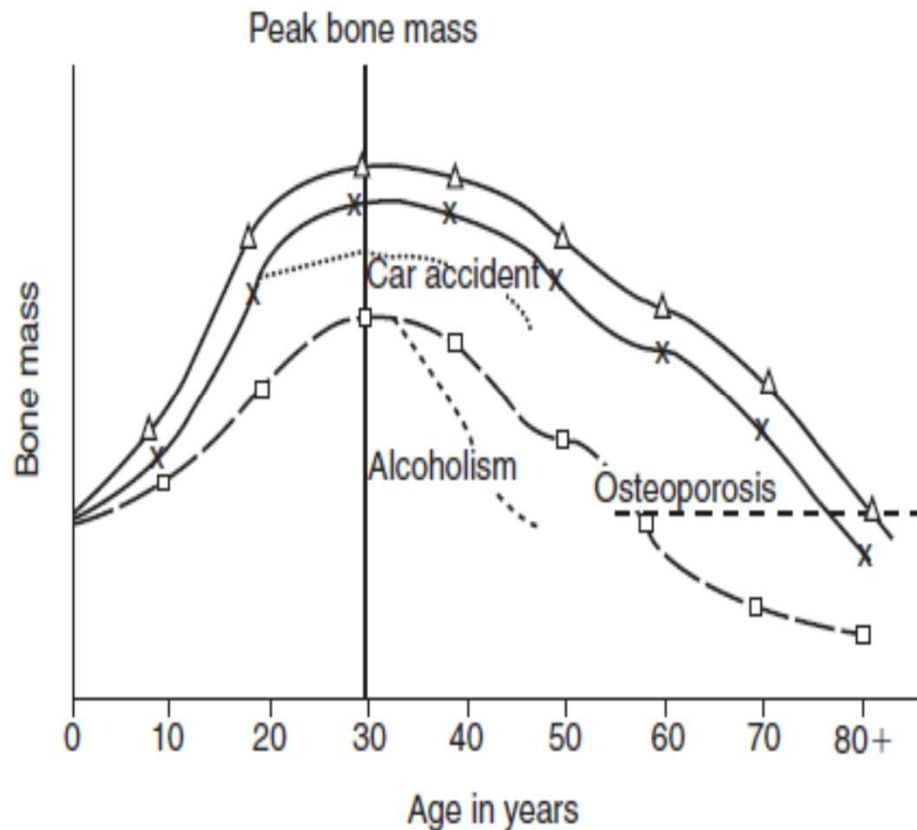


FIGURE 3-3 Bone mass profiles of three women throughout the course of a lifetime. The top line (Δ) represents usual lifestyle, including adequate nutrition including calcium, occasional or no weight-bearing exercise, some outdoor time (vitamin D exposure), minimal inactivity-related diseases, including obesity, modest alcohol intake, no drugs that diminish bone. The middle line (X) reflects optimal bone mass in a woman who embraced a healthy lifestyle over the course of her lifetime. Healthy lifestyle includes adequate nutrition including protein and calcium intake, a regular weight-bearing exercise program, routine exposure to sunshine, minimal disease burden, modest alcohol consumption, no drugs that diminish bone. The bottom line (□) reflects one of several possibilities: inadequate calcium during the teenage years and/or amenorrhea as a teen or early adult stage of life, or anorexia as a teenager with inadequate calcium and protein intake. Anorexia often results in low estrogen values as well. Major points: Calcium intake during adolescence is critical; loss of normal serum estrogen results in accelerated bone loss with age or failure to maximize bone stock in youth; poor lifestyle choices (e.g., alcoholism, sedentary lifestyle, poor nutrition) diminishes bone at all ages; and serious physical compromise (e.g., car accident with prolonged bed rest) has lifelong consequences.

- However, for some conditions, the pathology is made worse because of associated impairments that affect function, such as in the accelerated loss of strength that impairs balance and mobility.
- The loss of mobility rather than the medical condition itself becomes the functional consequence that causes the individual's disability.
- The good news is that, even in very sedentary individuals, when sedentary activities are broken up by short bouts of just 1 to 10 minutes of physical activity or standing, attenuation of the adverse effects of sedentary behavior can occur.



- For physical therapists, the ultimate goal of activity/exercise is to improve mobility and function and thereby decrease the patient's mobility disability.
- Mobility disability is defined as an inability to walk one-quarter of a mile(400m) and inability to climb a flight of stairs.
- For example, the majority of older hospitalized adults experienced a clinically significant decrease in community- related mobility in the first month after hospitalization from which 34% had not recovered during the 6 months of follow-up.
- Physical therapy professionals have a clear and important role to play in preventing and mitigating physical inactivity–related disability at all levels of the health care continuum.



PHYSICAL ACTIVITY GUIDELINES

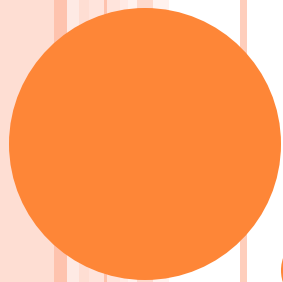
The Centers for Disease Control and Prevention (CDC) has established **specific physical activity recommendations** for **adults and older adults** (> 65 years of age) to achieve important health benefits and reduce the effects of age-related decline listed in **Table 23.2** in then Wellness **Chapter 23. Box 8.3** lists the step counts typically associated with sedentary to high activity levels.^{17,18}

Box 8.3

Physical Activity Step Counts^{17,18}

- Sedentary is < 5000 steps per day.
- Low active is 5000–7499 steps per day.
- Somewhat active is 7500–9999 steps per day.
- Active is > 10,000 steps per day.
- Highly active is > 12,500.





PHYSICAL STRESS THEORY

○ PHYSICAL STRESS THEORY

The physical stress theory (PST) has been the foundation of exercise prescription for many years.

Box 8.4

Application of the Physical Stress Theory

Level	Amount	Results	Example
Too much (extreme)	> 100% of maximum	Injury or tissue death	Weight bearing on an osteoporotic bone such as ulna, resulting in fracture
Appropriate stress	60%–100% of maximum	Adaptation	Loads of > 60% one-repetition maximum (1RM) resulting in strengthening
Usual stress	40%–60% of maximum	Maintenance (no change)	Walking at 5000–7000 steps will maintain current level of fitness
Too little stress	< 40% of maximum	Atrophy	Bed rest or sedentary activity
No stress	0% of maximum	Loss of ability to adapt (death)	Prolonged bed rest as in a coma or low responsiveness

AGING: A DECLINE IN HOMEOSTASIS

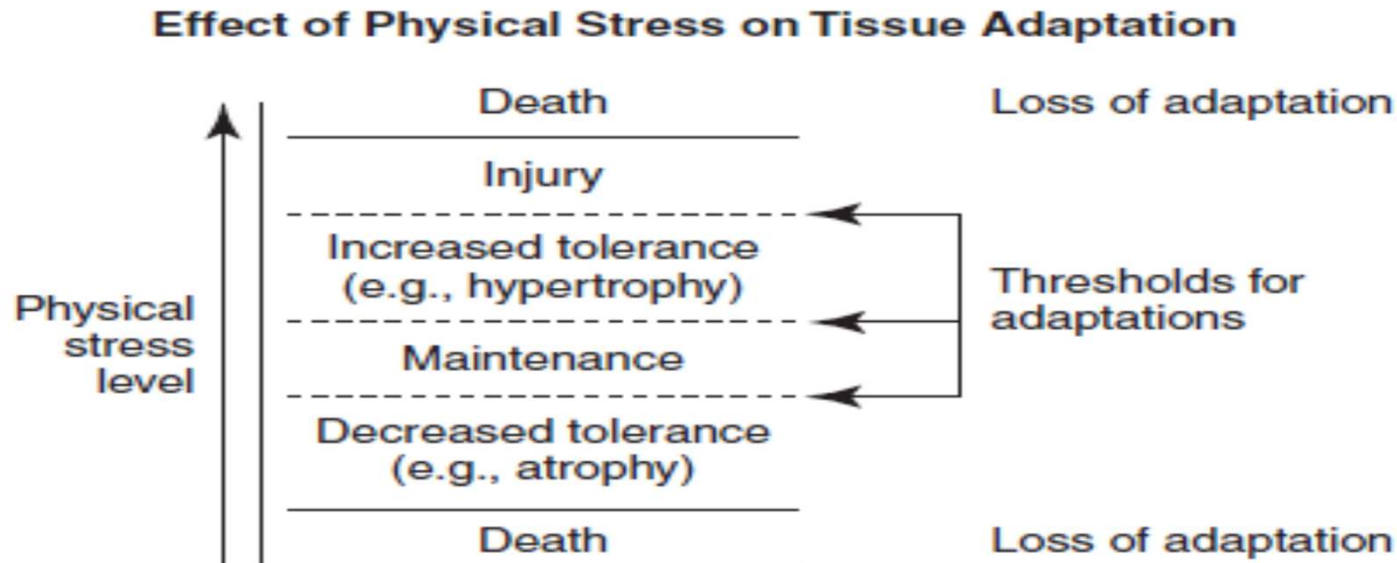


FIGURE 3-1 Effect of varying levels of physical stress (inadequately low to excessively high) on tissue's ability to adapt and to maintain homeostasis. (Reprinted with permission, from Muellér MJ, Maluf KS: *Tissue adaptation to physical stress: a proposed "Physical Stress Theory" to guide physical therapist practice, education, and research. Phys Ther 82(4):383–403, 2002.*)

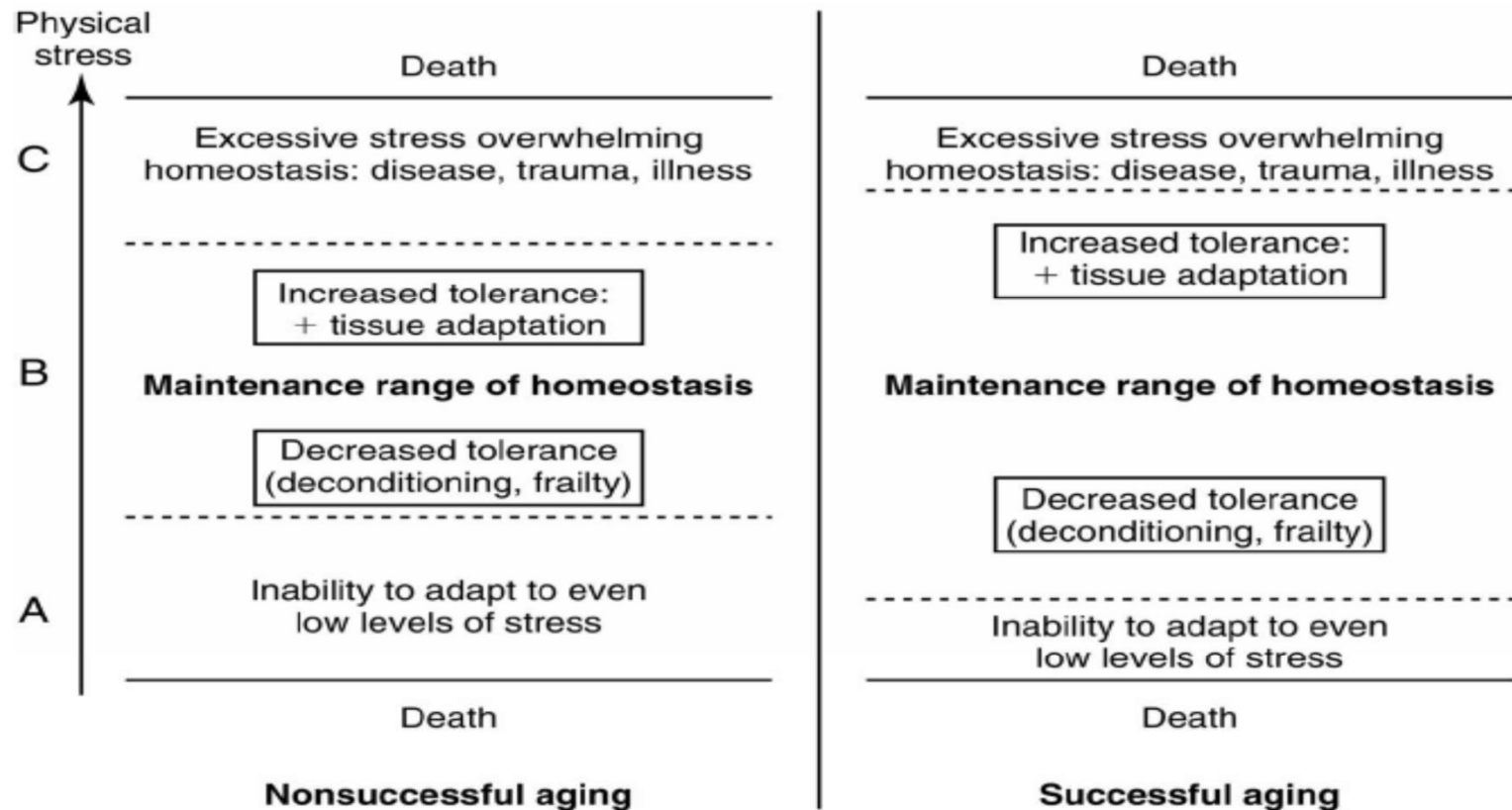


FIG. 3.2 A depiction of the differences in range of homeostasis tolerance and ability to adapt to stress in individuals who have aged nonsuccessfully and those who have aged successfully. The dotted lines represent the limits of homeostasis centered around the range of physical stress that maintains tissue at physiological equilibrium and the effect of increased or decreased stress on tolerance to challenges to homeostasis. **A**, Inadequate ability to adapt (maintain tissue homeostasis) against even small stresses. **B**, Level of stress that maintains homeostasis tolerance at the same level. **C**, Level of stress that overwhelms the tissue's ability to maintain homeostasis.

- The ability of tissue to absorb and dissipate forces is dependent on many variables, including the
 - time over which the stressor is applied;
 - the direction,
 - magnitude,
 - and combination of stressors applied;
 - the physiological condition of the tissue, organ, or system;
 - the frequency of the application of a stressor and length of time between the applications;
 - and even the psychological state of the person
 - and the environment or context in which the stressor is applied.
- In the clinic, physical therapists can modify these variables within an exercise program to achieve a desired outcome.
- For example, the PST can be used to positively impact the cardiopulmonary, musculoskeletal, and vestibular systems in a frail, sedentary older woman who has increased fall risk and an inability to tolerate walking 1000 feet (community distance) at a reasonable pace.



GENERAL INDICATIONS AND PRECAUTIONS

- Although exercise of any type has been shown to be safe and effective with appropriate supervision for nearly all older people (refer to ACSM's list of absolute contraindications²), the therapy professional should be aware of extrinsic and intrinsic variables that may adversely affect the desired exercise response in an older adult.
- For example, when a patient complains of excessive fatigue or muscle pain and does not appear to be gaining strength according to your expectations of the exercise prescription, the state of hydration, electrolyte imbalance, and the use of statins should be considered. Box 8.5 describes the effects of statins on muscle.³⁶

Box 8.5

Effects of Statins on Muscle


- The most common adverse events of using statins involve muscle pain and weakness (myopathy and rhabdomyolysis). Symptomatically, the urine may appear brown in the presence of rhabdomyolysis.



- Complaints usually occur within a few months of starting a statin or of increasing the dose, but there have been cases occurring after years of stable statin treatment.
- While creatine phosphokinase (CPK) levels are not useful in most cases of myopathy, any complaint of muscle weakness or bilateral proximal muscle pain with no obvious cause such as resistance exercise should be evaluated with a measurement of CPK.
- Stopping statin use reverses these side effects, usually leading to a full recovery within a few weeks.
- Although the risk is low, the risk is elevated with higher doses and interacting drugs.
- Patients with renal involvement, hypothyroidism, serious debility, or frailty, or those who are older than 80 years are more susceptible than others to myopathy.



BLOOD GLUCOSE

- Exercise lowers blood glucose, making individuals prone to hypoglycemia. Persons with diabetes should monitor blood sugars closely during and after physical activity and exercise, recognizing that insulin requirements may decrease with exercise.
 - The risk of incurring exercise-induced hypoglycemia can be mediated by the consumption of an extra 20 to 30 grams of carbohydrates during and after exercise.
 - Also, awareness of an exercise-induced phenomenon in diabetic patients known as delayed-onset hypoglycemia (e.g., low blood glucose concentration 6 to 15 hours after exercise) can help prevent problems through proper education.
 - Eating meals of small portions and at greater frequency can help to avoid delayed-onset low blood glucose response after exercise.
 - If blood glucose falls to or below 100 mg/dL, consuming 15 to 20 grams of carbohydrates is necessary, and then blood sugar should be rechecked, repeating every 15 minutes until blood glucose is at least 100 mg/dL.
- 

PAIN

- Although pain is a **common complaint** of an older adult and may present **as a barrier to exercise**, **there is no evidence supporting the decision to curtail exercise in the presence of pain.**
- Certainly, the therapist should be aware of pain caused by **acute inflammation** or injury, but **most pain complaints in older adults** may be **considered long-standing, or chronic.**
- In fact, a preponderance of studies document the **improvement in pain levels** with **progressive exercise** for a **variety of conditions** that include **osteoarthritis, low back pain, and chronic pain.**
- **The exercise prescription should be individualized** and carefully administered to achieve the pain reduction benefits of exercise. Patient education and patient-centered goal setting are key to working with the patient with chronic pain who will benefit from exercise.

ELEMENTS OF AN EXERCISE PRESCRIPTION

- Appropriately **designed exercise** is a **powerful intervention**.
- The **basic elements** of an exercise program include

1-specificity

type of contraction,
speed of contraction,
variety

2-progressive overload.

intensity,
duration,
frequency,
rest,
type of contraction,
speed of contraction,
reversibility,
variety.



SPECIFICITY

- Specificity includes the specific exercise, type of muscle contraction, speed of contraction, and consideration of the functional movement inherent in the desired outcome.
- Incorporating the same type of muscle contraction (concentric, eccentric, or isometric) that is elicited in a specific movement meets the requirement of specificity in resistance training.
- For example, trunk muscles are often used as stabilizers during movement and therefore should be trained isometrically in multiple planes and actions.



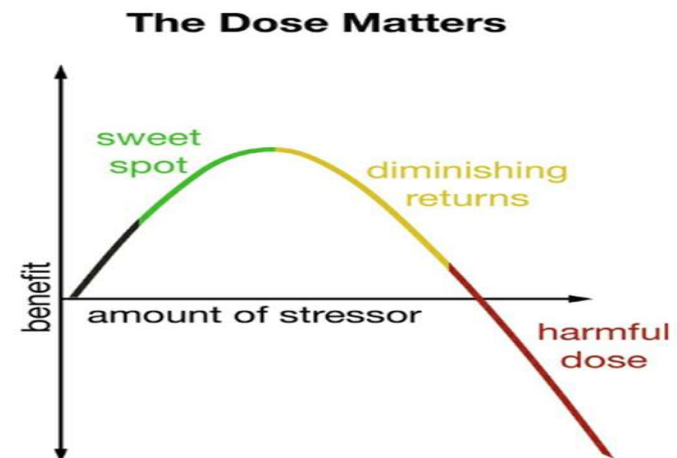
- Specificity is less critical within types of aerobic exercise. One study investigating the effects of exercise mode, training status, and specificity on oxygen uptake (VO₂) found that training level had more effect than the exercise mode.
- Logically, training on a treadmill will not directly transfer to a swimming task, even in the presence of greater aerobic capacity.
- Specificity in aerobic exercise may be most critical during maximum effort, such as in competition, but less important in individuals who are not achieving maximal effort.
- The specificity concept has led to the contemporary practice of functional training.
- Functional training is the concept of training a movement rather than a muscle and requires neural activation.
- Training for speed and power is an application of specificity and overload and a necessary component of functional activities.



PROGRESSIVE OVERLOAD

- The overload principle states that to achieve adaptation, a stimulus **must be greater than what is required to maintain the current state**.
- Parameters that influence **overload in resistance training** include **intensity, sets, repetitions per set, frequency of sessions/week, duration of training (in weeks), rest, and reversibility**.
- The dose response relationship states that **with greater doses, greater gains occur**, up until the point of diminishing returns (see Fig. 8.2).

FIG. 8.2 Dose–response curve



- The dose–response relationship exists between strength increases and training variables such as volume, duration (weeks), and intensity.
- Training volume in terms of duration appears to be the most important variable of all the elements affecting intensity.
- Analysis from multiple meta-analyses confirm the training period as the only significant variable to improve muscle strength in the presence of multiple sets, repetitions, and frequency.
- An implication for practice is that the variables of overload can be manipulated to individualize the exercise prescription based on pain, perceived effort, preference, and postexercise soreness as long as consistency of training is maintained for at least 3 months, recognizing the principle of reversibility (discussed later) that states that training results diminish upon cessation of the training.
- The dose–response relationship appears to hold for resistance exercise for strength gains with an intensity of up to 90% of a one-repetition maximum (1RM),
 - for balance improvements in older adults up to 3 days per week,
 - for aerobic conditioning up to 80% of the heart rate reserve (HRR).



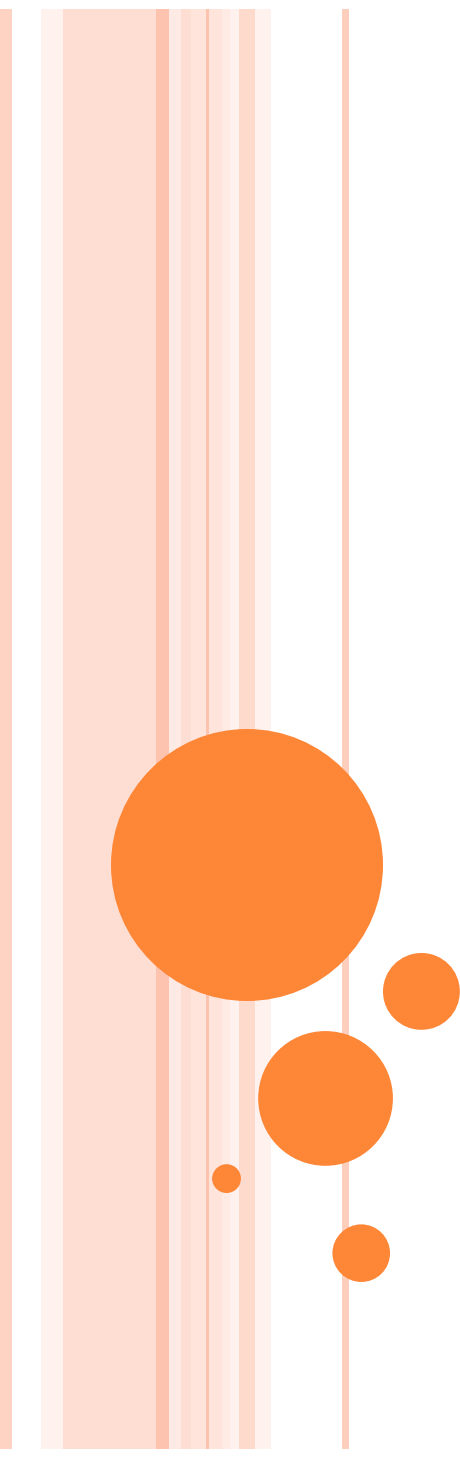
- However, the dose–response relationship does not hold for the relationship between exercise and cognitive function, where shorter sessions of 20 minutes or less showed the largest effects, whereas longer sessions show diminishing results.
- Performance of functional training such as chair rise and stair climbing does not demonstrate a dose–response relationship, perhaps because of the ceiling effect of the strength necessary to perform specific functional tasks.
- The minimum amount of overload to achieve cardiovascular gains is 50% of one's VO₂ maximum (220 – age) or heart rate reserve (maximum heart rate minus resting heart rate).
- For skeletal muscle strength gains, 60% of the maximum tissue capability should be met, although this level is controversial.
- Traditionally, this 60% threshold applies to untrained individuals, such as most older adults who are not exercising currently.



REVERSIBILITY

- The level of fitness, age, length of time in training, habitual physical activity, muscle groups involved, and genetic factors add to this variability.
- Although physiological changes occur as soon as 1 to 2 weeks after cessation of exercise, most well-trained adults will see only modest declines in their fitness and performance over periods of several months.
- Generally more exercise is required to improve cardiopulmonary fitness and cardiometabolic health than is required to maintain these improvements.
- **Resistance training**—induced improvements in muscle strength and power reverse quickly with complete cessation of exercise, although only one session/week at moderate to hard intensity may be required to maintain muscle and power fitness.





APPLICATION OF PRINCIPLES TO EXERCISE TYPES

AEROBIC EXERCISE

APPLICATION OF PRINCIPLES TO EXERCISE TYPES

AEROBIC EXERCISE

- Aerobic training at a mean intensity of 66% to 73% HRR with 40 to 50 minutes per session for 3 to 4 days/week for 30 to 40 weeks appears to be effective and optimal for maximum cardiopulmonary benefits in healthy sedentary older adults.



INTERVAL AND HIGH-INTENSITY INTERVAL TRAINING

- Interval aerobic training programs are **the most efficient to improve cardiopulmonary and endurance performances** and **general health, even in older adults**.
- Interval training is **suitable for healthy adults** and those with **cardiorespiratory disease, vascular disease, and diabetes**.
- The advantages of an **interval program** over **constant intensity programs** are the **superior improvements** in several cardiovascular outcomes, as well as in fitness and performance, even in those with cardiopulmonary and vascular disease.
- **Box 8.6** lists the benefits of interval and HIIT training.
- **Interval training** may be **more effective in untrained individuals** than **sustained aerobic activity** of similar duration in improving cardiopulmonary fitness and **blood glucose concentrations** **but less effective** in improving resting heart rate, body composition, and **total cholesterol-to-high-density lipoprotein (HDL) ratio**.



Box 8.6

Benefits of Interval and High-Intensity Interval Training (HIIT) for Older Adults

Healthy Older Adults

- Reduces subcutaneous fat, especially abdominal fat
- Reduces total body mass
- Improves VO_2 max
- Improves insulin sensitivity
- Burns more calories than continuous moderate exercise (CME)
- Increases postexercise fat oxidation and energy expenditure more than CME
- Decreases total cholesterol and low-density lipoprotein cholesterol while increasing high-density lipoprotein cholesterol more than CME
- Improves endothelial function
- Improves blood pressure
- Improves glucose regulation
- Reduces risk of cardiovascular events
- Decreases all-cause mortality

High-Risk Older Adults

- Reduces blood pressure
- Improves endothelial function
- Improves lipid profiles
- Improves VO_2 max
- Improves left ventricular function
- Improves overall myocardial function
- Reverses left ventricular remodeling in heart failure patients



- HITT is a form of interval training exercise in which individuals alternate periods of short, intense, nonoxidative exercise at maximum effort with less intense recovery periods.
- HIIT allows equal or improved outcomes for markedly less time investment and is associated with greater adherence, with results apparent in as little as 2 weeks.⁷⁷

- Examples of HITT protocols are listed in Table 8.3.

Although few studies have examined HIIT on older adults, the Generation 100 study,¹⁹ using HITT principles, demonstrated 60% adherence to the prescribed intensity (≥ 15 on the Borg scale) at two times/week over 1 year without strict supervision, although women had a lower adherence rate with high-intensity exercise than did men.

- HITT is known to be safe for healthy older adults as well as those with diabetes, stable angina, and heart failure, and after myocardial infarct, cardiac stenting, and coronary artery grafting.



Table 8.3**Protocols for High-Intensity Interval Training Shown to Be Effective in Accomplishing the Stated Purpose**

Purpose	Second Stage (Once Acclimated to Type of Exercise)
Improve cardiopulmonary function in those participating in cardiac rehabilitation programs ⁵⁶	2 × 8-minute interval blocks of 30 seconds at 80%–100% of peak power output interspersed with 30-second active or passive recovery, passive recovery permitted between blocks
Improve aerobic fitness, cardiac function, lipids, and glucose control in patients with cardiometabolic disease ²¹³	4-minute intervals of high-intensity treadmill walking (usually “uphill”) interspersed with periods of moderate-intensity walking
Improve aerobic fitness, cardiac function, and metabolic risk factors in previously sedentary older adults ⁷⁵	4 × 4-minute intervals at 90% peak heart rate interspersed by 3 × 3-minute active recovery periods at 70% HR peak for a total of 25 minutes on a non-weight-bearing all-extremity ergometer
Improve vascular function ⁷⁷	4 × 4 HIIT at 85%–95% of HR max interspersed with 3 minutes of active recovery at 60%–70% HR max, 3 times/week for 12–16 weeks
Beginners who have been cleared for exercise	2 sessions/week 40%–50% HR max in recovery; 80%–90% HR max in work period 1–4 minutes Recovery is greater than or equal to work period; return HR to 40%–50% HR max through active recovery Progression 1: 60 seconds × 10 Progression 2: 2 minutes × 8 Progression 3: 4 minutes × 4

MODE

- The modality of aerobic exercise should be **rhythmic and repetitive in nature** and **involve large muscle groups**. Common modes include **walking, stair climbing, hiking, jogging, running, social dancing, cycling, swimming, cross-country skiing, skating, rowing, and playing tennis, racquet sports, basketball, soccer, volleyball, and others**.
- A host of **equipment** can be used indoors for aerobic conditioning of the older individual, including **a treadmill, elliptical trainer, stair stepper, rower, stationary bike, and recumbent-type bike**.
- Outdoor activities include **walking or hiking, cross-country skiing, skating, jogging, and cycling**.
- **Each** activity has **advantages and disadvantages**.
- The **individual's preference** should be the **basis for recommending a specific type of aerobic exercise**.
- The best activity is the one that the individual will do consistently.



- Aerobic exercise may be one aspect of a complete exercise program for an older adult.
- Considerations of physical impairments, functional deficits, and patient goals need to be considered and the exercise mode individualized.
- Strengthening exercises may need to be done prior to participation in aerobic conditioning to enable aerobic conditioning to occur, especially if the person complains of pain or Fatigue.





APPLICATION OF PRINCIPLES TO EXERCISE TYPES

SPEED, POWER, AND PLYOMETRICS

Speed and Power

- Power rather than strength is a better predictor of functional abilities such as stair climbing, gait speed, and chair rise.
- The loss of muscle power is associated with slowness, an increased risk of falling, impaired functional performance, and frailty.
- Slowness occurs in part because of a preferential loss of type II or fast-twitch muscle fibers, which happens at twice the rate as strength loss and in part because of disuse.



POWER TRAINING

- High-velocity power training is feasible, is well tolerated, and can effectively improve lower extremity muscle power and function in healthy older men and women, older women with self-reported disability, older adults with mobility limitations, and frail women over 80 years of age.
- Because many movements intrinsic to balance require a response in milliseconds, the risk of accidental falls and injury indicates the need for a power component in an older adult's exercise program.
- Power training is distinguished from resistance training by the intention to move with maximal velocity.
- Moving a load “as fast as possible” has a moderate advantage over resistance training at any load in improving physical function, and is an equal or better predictor of functional performance than maximal force.
- Although power improves with any resistance (20% to 80% 1RM), there appears to be a dose–response relationship to resistance training and velocity, with the largest gains achieved with the highest loading intensity (80% 1RM). However, lower loads allow for greater emphasis on speed and power and possibly postural control.



- De Vreedeet al. reported that a 12-week intervention using functional tasks performed as quickly as possible with progressive resistance through weighted vests resulted in significant improvements in functional task performance.
- For a group of older women residing in a nursing home, utilizing body weight with traditional lower extremity exercises such as hip abduction, hip extension, heel rises, hamstring curls, and squats, and progressing to elastic bands and gradually adding a speed component demonstrated improvements in the timed up and go (improvement of 6.3 s), chair stand (increased by four repetitions), and gait speed (decreased by 4 seconds) over 10 weeks.
- Once an older adult achieves two sets of a resistive exercise or movement with good form and no pain, it is appropriate to add power challenges to the exercise program.
- When training for power, care should be taken to not overload the movement so that it alters the desired movement pattern. In other words, quality of movement prevails over speed.
- Finally, better training results are reported for frail older adults in programs where speed and power training are supervised.



Functional training

- Functional training can incorporate tasks while challenging balance through the progression from parallel stance to staggered stance to tandem stance and finally to unilateral stance.
- At the same time, the patient can be challenged to perform activities further and further away from his or her base of support and through multiple planes of movement, eyes closed or gaze off the feet, moving head side to side, and progressing to a compliant surface.
- Squats and lunges can be incorporated into functional training using the same base of support and principles of progression.
- Examples of techniques to overload the patient's gait training session include increasing walking speed or directional movements or adding dual tasking (e.g., carrying a full glass of water), uneven surfaces and obstacles, head turns while walking, or carrying a large object such as a laundry basket that blocks direct vision of the feet.
- Table 8.8 and Figs. 8.10 through 8.19 provide examples of functional training exercises specific to common functional tasks.



Table 8.8

Functional Tasks and Suggested Functional Training

Task	Functional Training
Bed mobility	Bridge progression (Fig. 8.15) Sit-backs (Fig. 8.6) Plank (modified and full) (Fig. 8.5) Side plank (regular and modified) (Fig. 8.5) Rolling
Transfers and squats	Sit to stand from various heights and types of surfaces (compliant and firm) with arms extended (Fig. 8.13) Squats with knees abducted and hips externally rotated



	Leg press, wall slides
Reaching overhead	Overhead press Jump squats
Walking and stair climbing	Plank (modified and full) (Fig. 8.5) Lunges (partial and full) Step-ups (varied heights) Eccentric step-downs (Fig. 8.16) Box steps or agility ladder for directional steps Heel raises (single and double) Toe tapping with and without resistance and speed Concentric followed by eccentric dorsiflexion Pushing large object Speed work Farmer's carry (Fig. 8.17)
Floor transfers	Kneeling with trunk rotations, extension, upper extremity movements Quadruped trunk rotations and hip extensions Lunges (Fig. 8.18) Kneeling to half kneeling Mountain climbers (Fig. 8.19)
Bending over to pick up something from floor	Hip hinge to dead lifts; lifting from varying heights (Fig. 8.12)
Carrying	Farmer's carry
Mobility training	Standing weighted ball tosses Kettle bell swings Carrying laundry basket



FIG. 8.10 Floor rise.





FIG. 8.11 Overload principle applied to supine-to-sit transfer.





FIG. 8.12 Dead lift.



FIG. 8.13 Sit-to-stand or -squat progression.





FIG. 8.14 Squat thrust from chair.





FIG. 8.15 Bridge progression. **A**, Bridge with arms to side. **B**, Bridge with arms elevated. **C**, Single-leg bridge



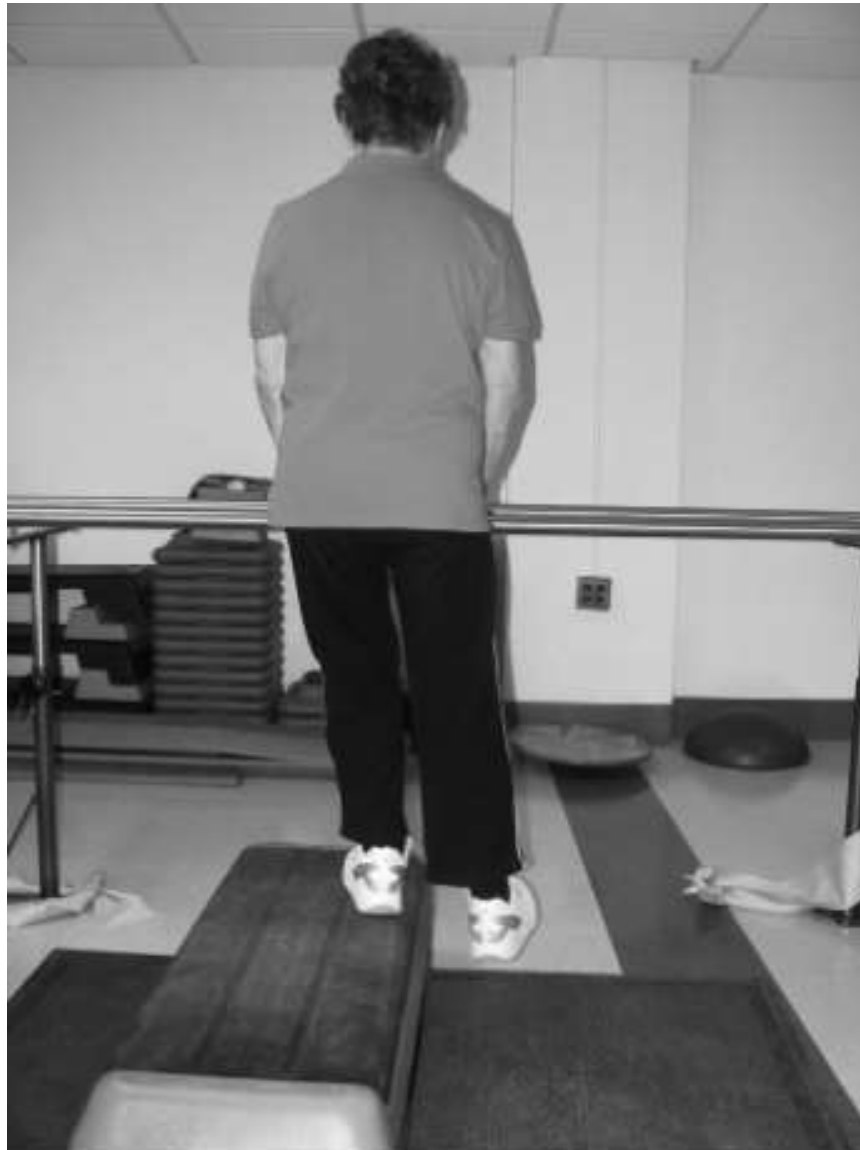


FIG. 8.16 Eccentric step-down.





FIG. 8.17 Farmer's carry.





FIG. 8.18 Lunges.






FIG. 8.19 Mountain climbers.



- The optimal intensity of functional training has not been determined.
- However, improvements in functional performance from frequencies of ≥ 2 to 3 days/week with exercise sessions of ≥ 20 to 30 minutes in duration for a total of ≥ 60 minutes of neuromuscular exercise per week were found in one review.
- Integrating functional exercises into daily life is an alternative to structured exercise programs, especially for the very old and frail.
- Integrated functional exercise programs aim to turn daily routines into opportunities for exercising rather than performing separate exercises, such as purposeful walking (to store, church), tandem walking on the way to the kitchen, stair climbing, obstacle crossing, or rising from a chair.
- The Lifestyle-integrated Functional Exercise (LiFE) program is a physical therapist-led, evidence-based program focusing on embedding functional activities into daily life, thereby enhancing overall level of physical activity. The program is taught by professional trainers during five to seven home visits and two follow-up phone calls over a 6-month period.
- LiFE activities are linked to daily tasks by using situational and environmental cues (e.g., tooth brushing) as prompts to action. The idea of LiFE is to perform the activities intentionally and consciously until they become a habit.

Outcomes of the program included improved balance, reduced falls (31%), lower extremity strength, functional performance, and improved physical activity.

FUNCTIONAL TRAINING AND MULTICOMPONENT PROGRAMS

- Functional training is particularly effective in improving performance in ADLs of older adults.
 - Improvements in functional abilities are likely a result of strength and power training but are more likely to occur if the functional task is also practiced.
 - Simply walking on level surfaces at the same speed is not likely to transfer to more complex gait activities such as changes in speed or direction unless those parameters are specifically practiced.
 - Because muscle power shows a higher correlation to functional performance than muscle strength, training for speed with body weight improves chair rising and stair climbing ability more so than with traditional strength training.
 - Interventions incorporating multiple training components (e.g., training resistance, balance, endurance, coordination, and power using multicomponent exercises) demonstrate better functional outcomes than single-focus exercise.
 - Exercise types such as tai ji (taichi), qigong, and yoga involve varying combinations of neuromotor exercise, resistance exercise, and flexibility exercise and may offer functional carryover.
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APPLICATION OF PRINCIPLES TO EXERCISE TYPES

PLYOMETRIC TRAINING

PLYOMETRIC TRAINING

- Plyometric exercise, a form of power-based exercise, usually consists of an eccentric contraction followed by a concentric contraction of the same muscles.
- Plyometric exercise attempts to use the stretch reflex of the muscle spindle and the elastic energy that is stored in a stretched muscle to enhance an immediate reciprocal contraction in that muscle.
- For example, a patient would rapidly squat and then immediately jump through a ballistic contraction. In this example, energy is stored in the gastrocnemius as the ankle dorsiflexes and in the quadriceps as the knee flexes.
- As the person begins to jump, a strong and rapid contraction of the gastrocnemius and quadriceps propels the patient into a jumping motion.



- Plyometrics may aid in bone formation, according to Wolff's law, by increasing the compressive forces that the bone is required to absorb.
- Other authors have suggested that using plyometrics for increasing upper extremity power, such as in a boxing-type movement, aids in decreasing hip and head injuries associated with falling by allowing the person to get his or her arms out to absorb some of the force from the fall.
- Jumping has been shown to have a positive effect on decreasing fall risk in long-term care residents when combined with strengthening, stretching, and aerobic conditioning.
- Jump training in older adults (> 50 years) was found to be safe and effective in increasing muscle power in a recent meta-analysis.
- Jump landings train balance and promote joint stability through proprioceptive control and eccentric activation.
- Low-impact jumps such as bunny hops and quick heel raises can be used initially.
- Double-leg jumps (e.g., long jumps) and landings can afford greater stability than single-leg variations and may be a better place to start.
- Jumps onto a box can reduce impact forces compared with landing on the ground. Figs. 8.7 through 8.9 illustrate some plyometric exercises.



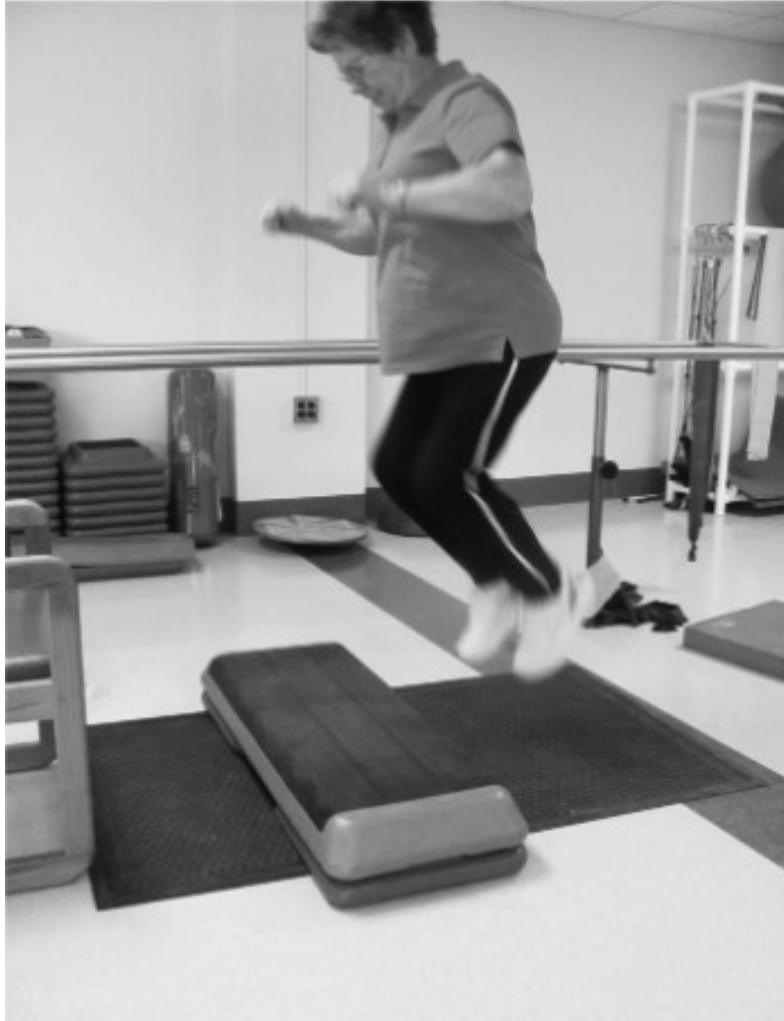


FIG. 8.7 Plyometric exercise jumping onto and off of a step





FIG. 8.8 Plyometrics, falling forward onto gym ball to increase upper extremity power.





FIG. 8.9 Plyometrics, jumping from foot to foot



- A conservative approach to plyometrics should be taken because beginning exercisers may not have the soft tissue and muscle integrity that is required.
- Therefore, as older adults progress in their exercise program, speed of contraction should be used first, before plyometrics is added.
- Quick unilateral movements performed functionally, as in a skipping-type exercise, is one way to achieve increased speed of muscle contraction with a load.
- Then bilateral movements, such as jumping in place, can be added. Refer to Table 8.7 for ideas of how to progress a jumping program



Table 8.7**Progression of Jumps and Plyometrics**

Beginner	Intermediate	Advanced
Balls of feet in contact with floor, hinge at hips, emphasize quickness of movement, agility, reciprocal movements of arms and legs, postural control	Emphasize lightness in landing with "soft knee" rather than velocity or distance, reciprocal movements, postural control	Emphasize lightness with power to achieve velocity and distance
Quick calf raises, single and double	Small jump, double stance	High jumps with arms outstretched
Bunny hops	Long jumps	Lateral jumps (up and over) on Bosu
Pivot and turn on floor	Donkey kicks	Box jumps
Weight shifting from foot to foot in multiple directions	Jump rope	Line hops
Jumping jacks without leaving the floor	Jumping jacks	Squat jumps
Scissors (rapidly criss-crossing feet in standing)	Skipping	Diagonal and side jumps
	Forward bounding	
Upper body: emphasize shoulder stability, postural stability		
Wall pushups	Wall bounces or catches	Stability ball body bounces
Bosu modified full plank (on hands)	Bosu rocks in full plank (flat side up)	Bosu ball plank shifts with arms (one arm on ball, one arm off, then switch)
Simulated boxing, emphasizing quickness of arms, varied stances	Combine boxing moves emphasizing foot work and quickness (upper cuts, jabs, hooks, etc.)	Combination boxing moves emphasizing power and foot work (e.g., jab-jab-cross; jab-right hand; jab-right hand-left hook)
Bouncing ball in double stance	Squats while bouncing ball, staggered stance	Squats while throwing ball
		Sit-ups combined with throwing ball

- While plyometrics—specifically jump training—is safe, adequate supervision to monitor and coach form is critical.
- A baseline strength of > 80% in both limbs and 90% to 95% pain-free range of motion in the weight bearing limbs are required before power and plyometric activities are added, which is indicated by correct technique without adaptations.
- Core and proximal strength are necessary for adequate postural control and stability. Adequate proprioception indicated by adequate joint stability is also necessary.
- In addition to creating a challenge to produce a quick contraction, plyometrics may also impose an overload to the cardiopulmonary system that may need to be monitored.
- Plyometrics should not be used in the presence of significant pain, inflammation, or joint instability.
- Coaching techniques such as demonstrating proper joint positioning and encouraging correct landing techniques (e.g., listening to the sound of the landing) can be effective ways of teaching force absorption skills.
- Twenty-five jumps per session seems to be the lower limit for effectiveness, which can be divided between exercises.
- Building up to 25 repetitions is recommended, focusing on alignment and landing technique and form.



- An innovative application of **overload and plyometrics**, described as the **LIFTMOR trial**, utilized high-resistance exercise with plyometrics to investigate the **effect on bone mineral density** and physical functioning in **postmenopausal women with osteopenia and osteoporosis**.
- The 8-month, twice-weekly intervention consisted of four **exercises during a 30-minute supervised program**. The program gradually **increased load over 1 month** to achieve correct form performing **deadlift, overhead press, and back-squat exercises**.
- Program volume was high at **five sets of five repetitions** maintaining an intensity of **80% to 85% 1RM**.
- Impact loading via **jumping chin-ups with drop landings** was performed with **close supervision** for **five sets of five repetitions** each.



- Eight-month results indicated increases in body height versus a loss in height for the control group (nonimpact, low-load balance and mobility program of similar length), improved bone mineral density in most participants compared with a loss of bone in 73% of the control participants, and improved functional performance.
- Additionally, compliance was slightly higher than the control group (both were > 80%).
- Importantly, there were no injuries other than one mild low back strain and no evidence of vertebral fractures in the intervention group.
- This novel intervention demonstrates the safety of high-intensity resistance exercise and plyometrics even in high-risk groups such as those with osteoporosis, promoting confidence to therapists in utilizing evidence-based principles in the design of exercise interventions.

