

AGING AND THE OLDER ADULT

Helen Buchanan, SPT

Portions adapted from Dana McCarty, PT, DPT,
PCS, C/NDT and Carol Giuliani, PT, PhD, FAPTA

Special thanks to Capstone Advisor Vicki Mercer, PT, PhD and Capstone Committee Members Tiffany Shubert, PT, PhD, and Carol Giuliani for their guidance and to Dana McCarty and Cathy Howes, PT, DPT, MS, PCS for their assistance.

Learning Objectives

1. Describe the general effects of aging and implications for function and mobility in older adults, including:
 - a. Effects of aging on the musculoskeletal, and nervous/sensory systems; and
 - b. Changes in postural control during adulthood and older adulthood.
2. Describe appropriate falls screening and assessment measures including their importance in physical therapy care for the older adult.
3. Identify current physical activity recommendations for adults and older adults.

General Effects of Aging

- ↓ in blood supply to tissues
- ↓ in number of reparative cells
- ↓ in tissue extensibility
- ↓ in metabolic activity
- ↓ in capacity for healing processes, including inflammatory response

MSK Changes: Bone

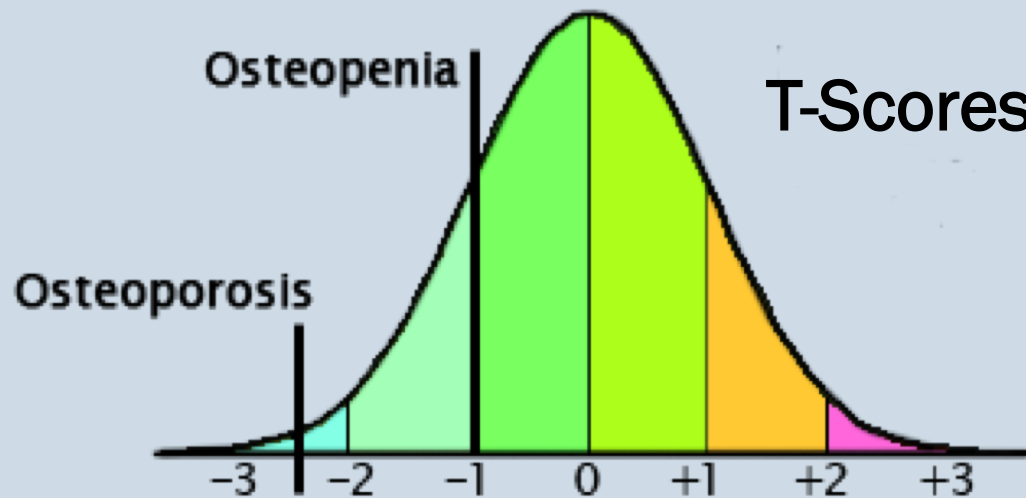
- Baseline of bone density determined by:
 - Physical activity in childhood/adolescence AND in adulthood
 - Maximal bone mass = late 20s to early 30s
- Loss of bone mass
 - ↓ formation of new bone (osteoblastic)
 - ↑ resorption of existing bone (osteoclastic)
- Bone loss results in:
 - ↓ bone strength
 - ↑ risk of fracture
 - Functional deficits

MSK Changes: Bone

- Initiation of bone loss
 - Men 30-50 years old
 - Men lose approximately 0.5% bone mass per year
 - Women 38-48 years old
 - Women lose 1% per year before menopause, 2-4% per year for 4-8 years after menopause, then 1% per year thereafter
 - Bedrest/Immobilization

MSK Changes: Bone

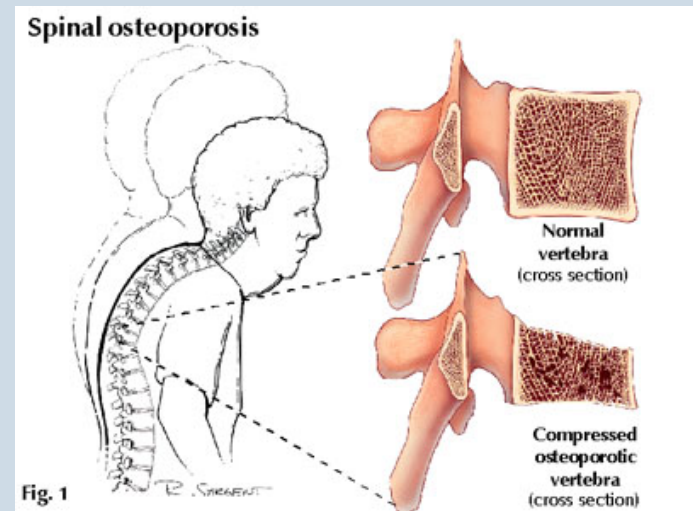
- Osteoporosis
- Osteopenia
- Osteomalacia



Osteopenia = t-score between -1 and -2.5
Osteoporosis = t-score below -2.5

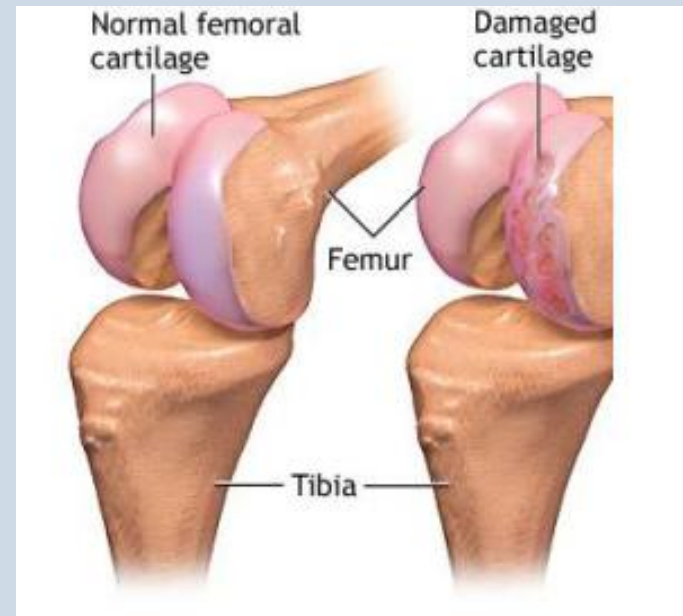
Bone Loss Recommendations

- Regular, ongoing physical activity
 - Weight-bearing activities 3-5x/wk
 - Low to moderate resistance
 - Alternating patterns
 - Strength/resistance training
 - Spinal extension
- Good nutrition
 - Calcium
 - Vitamin D



MSK Changes: Cartilage

- Composition changes with aging:
 - Thins, cracks, clefts = uneven surface
 - Dehydration
 - Poor nutrition/blood supply
 - Inability to repair
 - "Wear and tear"



MSK Changes: Cartilage

- Osteoarthritis/Degenerative Joint Disease
 - Primary impairments
 - Pain with movement, decreased joint ROM
 - Secondary impairments
 - Muscle weakness, bone spurs
- Degenerative Disc Disease
 - Most often in lumbar and cervical regions
- PT role?

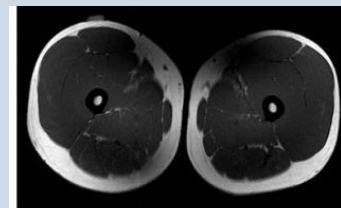
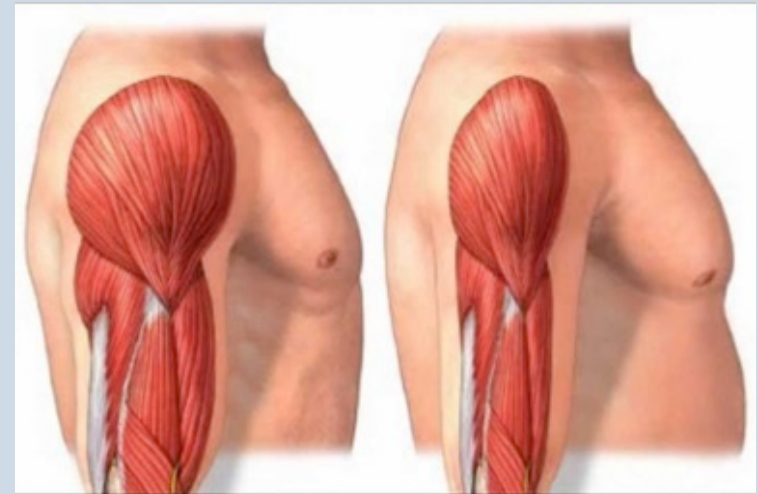
MSK Changes: Skeletal Muscle

- Strength peaks 20s to early 30s
- Muscle mass and strength decline:
 - Muscle mass ↓ 5% each decade
 - 30% ↓ in strength from 50-70 years old
 - More rapid ↓ after 70 years old
 - Leads to ↓ in both isometric and dynamic strength, but eccentric strength appears better maintained than concentric
- Bedrest/Immobilization
 - Loss of ~12% strength within 1 week
 - Loss of 50% strength with 3-5 weeks bedrest

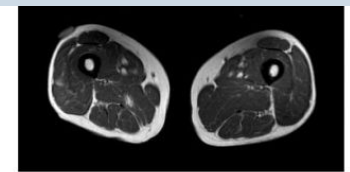
MSK Changes: Skeletal Muscle

■ Sarcopenia

- Lean body mass < 2 SD
AND gait speed < 0.8 m/s
- Etiology
 - Muscle disuse
 - Changes in CNS
 - Hormonal changes
 - Inflammatory effects
 - ↓ caloric intake
 - Changes in muscle structure and function



Young (18-25 years) muscle



Sarcopenic (>65 years) muscle

MSK Functional Implications

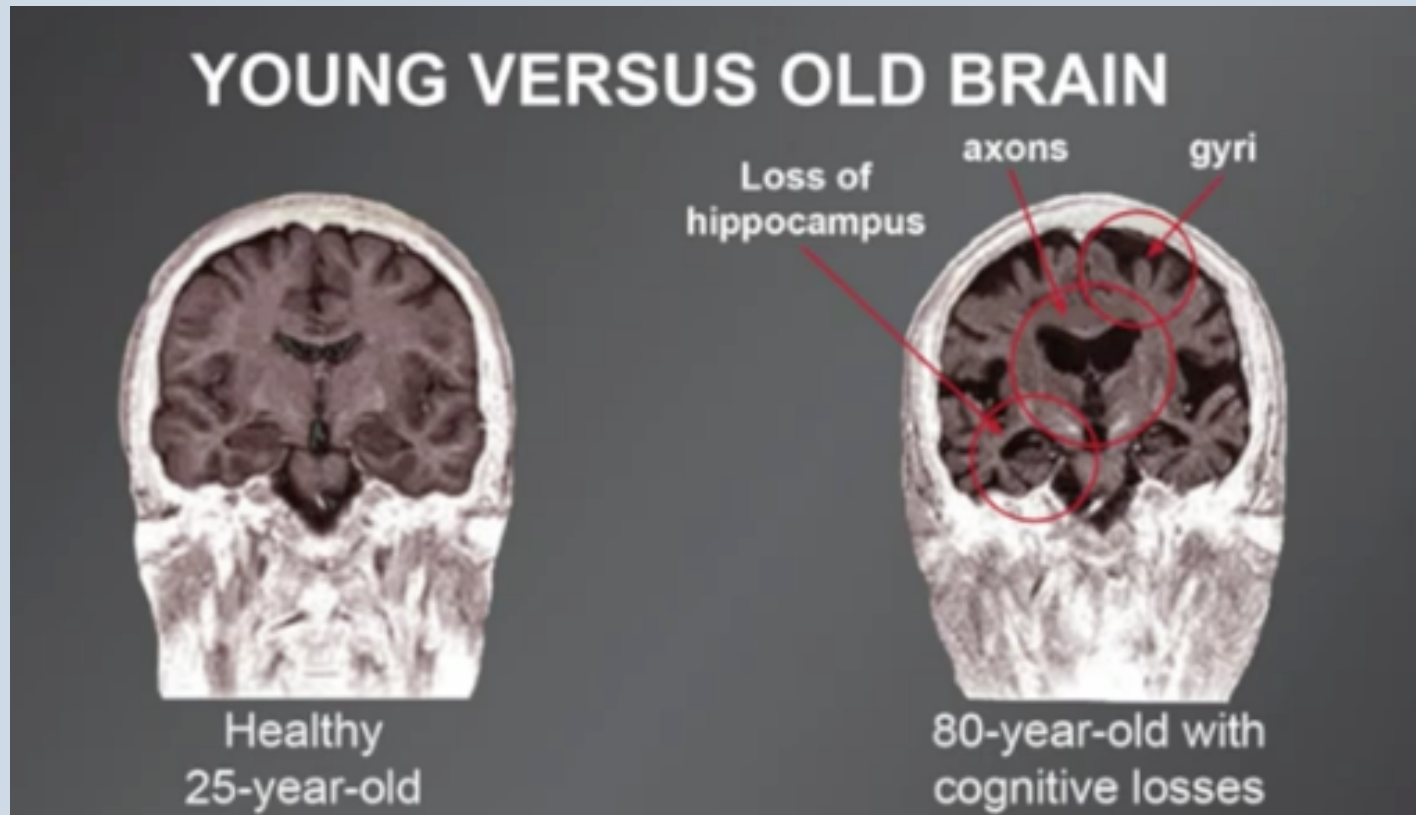
■ Summary:

- Loss of bone mass
- Loss of lubrication and shock absorption at joints
- Loss of muscle mass and strength

= ↓ *function*, ↓ *mobility*, ↑ *risk of fall/injury*

Neuro Changes: Brain

- Brain volume loss begins in 20s
 - Amount of decline depends on overall health



Neuro Changes: Brain

■ Changes include:

- Loss of gray matter due to neuronal cell death and/or cortical atrophy
- Enlargement of ventricles
- Loss of white matter due to axonal loss or ↓ in myelination
- ↓ blood flow to frontal, temporal, and occipital lobes
- Biochemical changes
 - ↓ dopamine, serotonin, and other enzymes associated with neurotransmitter function

■ Can be difficult to differentiate typical aging and preclinical pathology

Neuro Changes: Reaction Time

- Measure of nervous system efficiency
 - Amount of time between presentation of a stimulus and the motor response
- Fastest in young adulthood
- Slowed 15-30% in older adults
 - Fitness training has benefits = active older adults demonstrate quicker reaction time

Neuro Changes: Memory & Intelligence

■ Memory

- Component of cognitive function
- Declines in most types of memory with advanced age
 - Can affect how we teach tasks to older adults

■ Intelligence

- Intellectual ability peaks between 20-30 years old and is maintained until at least 75

Neuro Changes: Sensory

- Decline in sensory function begins in adulthood and progresses with advanced age
 - ↓ ability to detect pain
 - ↓ cold tolerance, ↑ sensitivity to heat
 - ↓ proprioception
 - ↓ ability to detect touch, ↑ threshold for vibration
- Not universal, can be associated with other disease processes (e.g. diabetes, stroke, etc.)
- May or may not lead to functional decline

Neuro Changes: Visual

■ Acuity

- Slight ↓ from 20-50 years old, more rapid ↓ from 60-80 years old
- Need more light to detect objects

■ Dark adaptation

■ Color discrimination

■ Contrast sensitivity

- Loss of depth perception

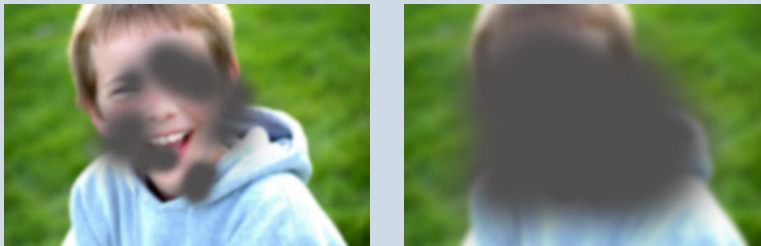
■ Presbyopia

- Diminished ability to focus clearly on near objects

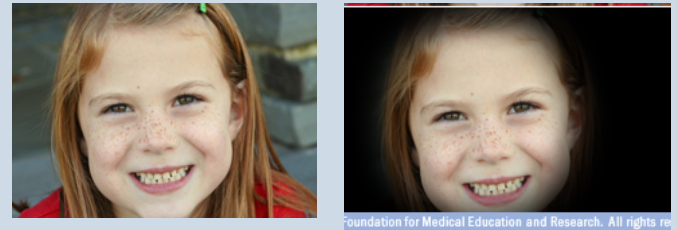
Neuro Changes: Visual

- Common visual pathologies

Macular degeneration



Glaucoma



Cataracts



Diabetic retinopathy



Neuro Changes: Vestibular

- Decline due to structural changes
 - Affects postural and ocular stability
 - Affects ability to resolve sensory conflicts
 - May result in dizziness or vertigo

Neuro Changes: Other Senses

■ Hearing

- Presbycusis
 - ↓ acuity, ↓ ability to localize sounds, inability discriminate high frequency tones
- 1 in 3 adults over age 65 has hearing loss

■ Taste and Smell

- Modest loss of taste
- Progressive decline in smell
- Can be due to medications

Neuro Functional Implications

■ Summary:

- Brain atrophy
- ↓ reaction time
- Memory loss
- Sensory loss: somatosensory, vision, vestibular, etc.

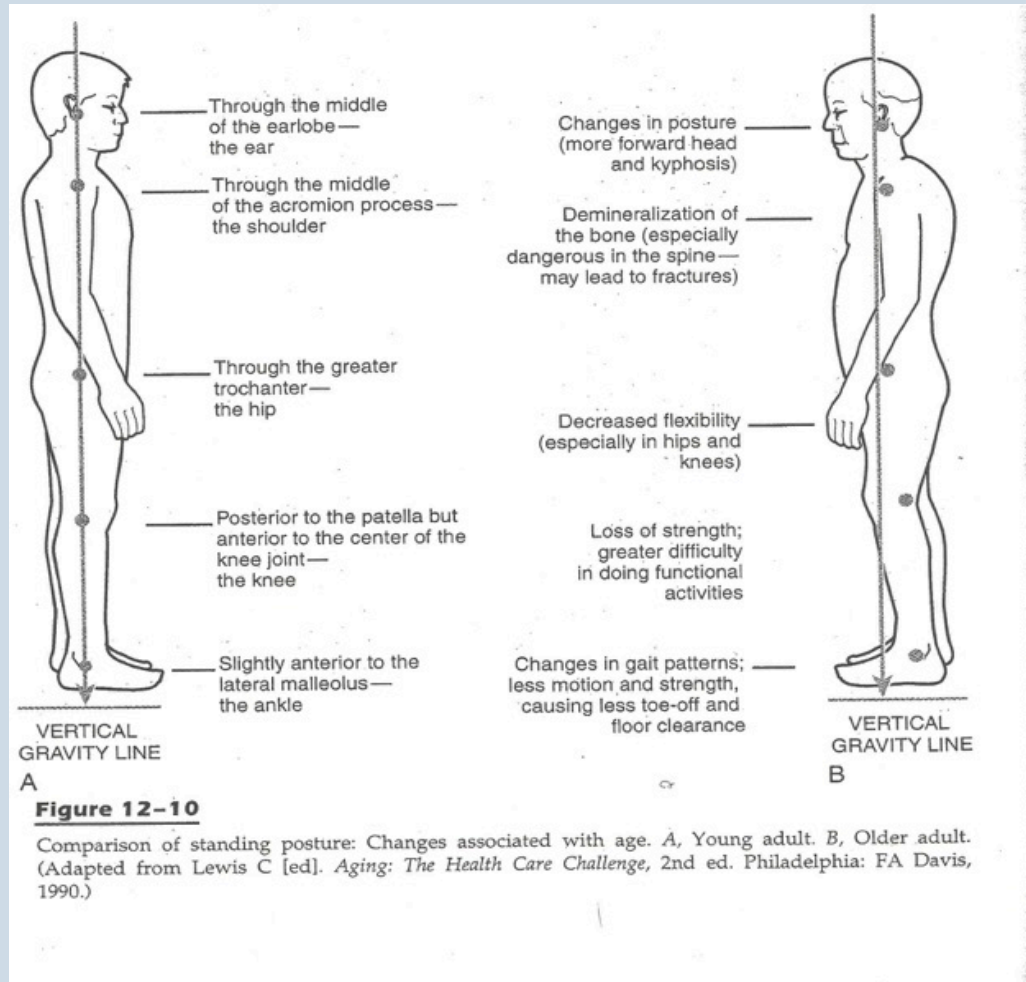
= *impaired sensory integration,*

↓ function, ↓ mobility, ↑ risk of fall/injury

Posture, Balance, & Movement

- Ability to maintain upright posture and proper alignment ↓ with advanced age
 - Spinal curves change, change in vertebral discs
 - ↓ muscle strength affects ability to maintain
 - Loss of hip, knee, and ankle mobility
 - Less organized motor patterns
- Impairment in any one system can change functional abilities
 - Usually require the integration of several sensory and motor systems

Postural Changes



Postural Sway & Response

■ Postural sway

- Less sway in quiet standing = better balance
- Greater sway in young children and older adults
- Amount of postural sway > in females of all ages due to ↓ muscle mass

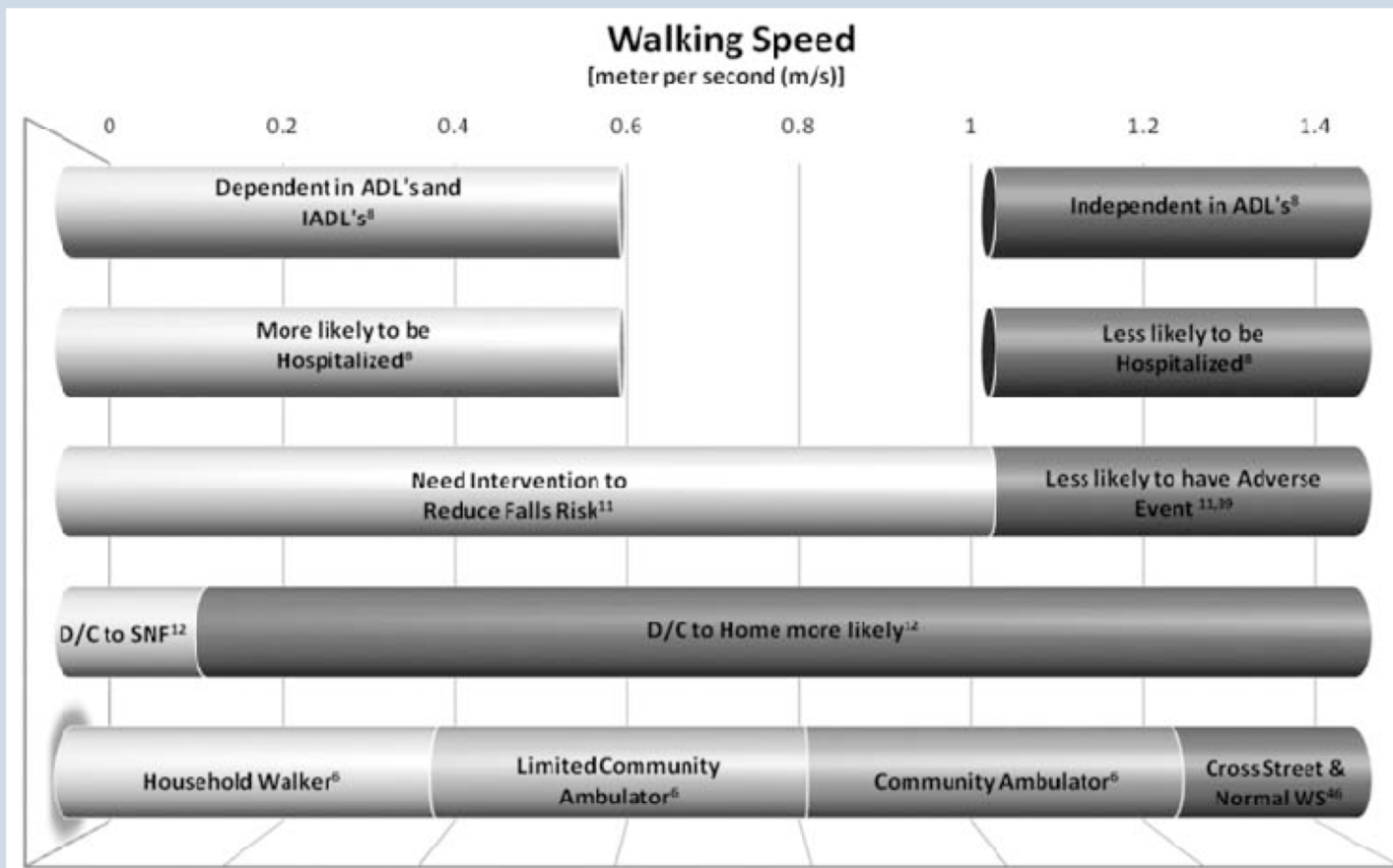
■ Postural response strategies

- Activation efficiency may decline
- Anticipatory postural responses may be slower
- ↓ limits of stability with weight-shifting

Dynamic Balance and Mobility

- Gait characteristics in older adults:
 - Shorter step length, greater step width
 - More frequent steps but slower gait speed
 - Greater out-toeing, wider base of support
 - Flat foot at initial contact
 - Increase in double support stance phase
 - Less pelvic rotation
 - Altered response to perturbations
- Multiple factors affecting gait, gait speed

Gait Speed Ambulation Classifications



Other Gross Motor Activities

■ Running

- Shorter stride, slower speed

■ Crossing obstacles

- Slower speed, smaller steps, lead foot closer to obstacle ↑ likelihood of making contact

■ Stepping up

- Longer period of double support prior to stepping up, ↑ trunk flexion/forward lean, ↑ hip flexion, ↑ plantarflexion

Contributors to Balance Decline

- Inactivity and lack of motor practice
- ↓ flexibility and muscle strength
- ↓ proprioception
- Changes in posture
- Changes in sensorimotor input and integration
- Visual changes and/or vestibular impairments affecting postural awareness and head stabilization
- Medication
- Pathologies
- Pain

Falls and the Older Adult

- 1 in 4 older adults fall each day
- 1 in 5 of those falls result in serious injury, including fractures or brain injury
- >95% of hip fractures result from a fall, resulting in at least 300,000 hospitalizations annually
- Women > men

But what is a *fall*?

Contributing Factors to Falls

Intrinsic

- ↓ strength/endurance
- ↓ flexibility and joint mobility
- Visual impairments
- Balance impairments
- ↑ reaction time
- ↓ attention to task
- Dizziness, fainting
- Fatigue
- Disease

Extrinsic

- Improper clothing
- Shoe wear
- Lighting
- Obstacles
- Irregular, uneven, or slippery surfaces
- Medication
- Substance use
- Rushing
- Assistive devices

Strategies to Decrease Falls Risk

- History of falls
- Review medical conditions
- Review medications → consult?
- Regular vision and hearing check-ups
- Physical activity and exercise to maintain strength, balance, and endurance
- Assess cognition
- Need, fit, and use of assistive devices
- Falls risk assessment

STEADI: Stopping Elderly Accidents, Deaths, & Injuries

- Initiative created by the CDC Injury Prevention and Control Center
- Published materials for healthcare providers and at-risk individuals
- Coordinated approach by algorithm:
 - Screen
 - Assess
 - Intervene

<https://www.cdc.gov/steady/index.html>

STADI Algorithm for Fall Risk Screening, Assessment, and Intervention among Community-Dwelling Adults 65 years and older

START HERE

1 SCREEN for fall risk yearly, or any time patient presents with an acute fall.

Available Fall Risk Screening Tools:

- Stay independent: a 12-question tool [at risk if score ≥ 4]
- Important: If score < 4 , ask if patient fell in the past year (if YES \rightarrow patient is at risk)

- Three key questions for patients [at risk if YES to any question]
 - Feels unsteady when standing or walking?
 - Worries about falling?
 - Has fallen in past year?
 - If YES ask, "How many times?" "Were you injured?"

SCREENED **NOT** AT RISK

PREVENT future risk by recommending effective prevention strategies.

- Educate patient on fall prevention
- Assess vitamin D intake
 - If deficient, recommend daily vitamin D supplement
- Refer to community exercise or fall prevention program
- Reassess yearly, or any time patient presents with an acute fall

SCREENED AT RISK

2 ASSESS patient's modifiable risk factors and fall history.

Common ways to assess fall risk factors are listed below:

Evaluate gait, strength, & balance

Common assessments:

- Timed Up & Go
- 4-Stage Balance Test
- 30-Second Chair Stand

Identify medications that increase fall risk (e.g., Beers Criteria)

Ask about potential home hazards (e.g., throw rugs, slippery tub floor)

Measure orthostatic blood pressure (Lying and standing positions)

Check visual acuity

Common assessment tool:

- Snellen eye test

Assess feet/footwear

Assess vitamin D intake

Identify comorbidities

(e.g., depression, osteoporosis)

3 INTERVENE to reduce identified risk factors using effective strategies.

Reduce identified fall risk

- Discuss patient and provider health goals
 - Develop an individualized patient care plan (see below)
- Below are common interventions used to reduce fall risk:

Poor gait, strength, & balance observed

- Refer for physical therapy
- Refer to evidence-based exercise or fall prevention program (e.g., Tai Chi)

Medication(s) likely to increase fall risk

- Optimize medications by stopping, switching, or reducing dosage of medications that increase fall risk

Home hazards likely

- Refer to occupational therapist to evaluate home safety

Orthostatic hypotension observed

- Stop, switch, or reduce the dose of medications that increase fall risk
- Educate about importance of exercises (e.g., foot pumps)
- Establish appropriate blood pressure goal
- Encourage adequate hydration
- Consider compression stockings

Visual impairment observed

- Refer to ophthalmologist/optometrist
- Stop, switch, or reduce the dose of medication affecting vision (e.g., anticholinergics)
- Consider benefits of cataract surgery
- Provide education on depth perception and single vs. multifocal lenses

Feet/footwear issues identified

- Provide education on shoe fit, traction, insoles, and heel height
- Refer to podiatrist

Vitamin D deficiency observed or likely

- Recommend daily vitamin D supplement

Comorbidities documented

- Optimize treatment of conditions identified
- Be mindful of medications that increase fall risk

FOLLOW UP with patient in 30-90 days.

Discuss ways to improve patient receptiveness to the care plan and address barrier(s)



Centers for Disease Control and Prevention
National Center for Injury Prevention and Control

Falls Risk Screen vs. Assessment

- What's the difference?
- Why do both?



Falls Risk Screening

- 3 key questions:
 1. Unsteady when standing or walking?
 2. Worried about/fearful of falling?
 3. Fallen in the last 6-12 months?
- STEADI Stay Independent Questionnaire
 - A 12-question self-check tool
 - Score of 4 or more indicates fall risk

Falls Risk Screening Results

Less Risk

- Reassess annually
- Educate in fall prevention and risk management
 - Exercise
 - Home safety

Increased Risk

- Screen further
 - Medications
 - Cognitive impairment
 - Polypharmacy
 - Orthostatic hypotension
- Assess
 - Gait, strength, balance
 - Environmental hazards
 - Feet/footwear

Falls Risk Assessment

■ Importance of individualization

- What additional information is important based on the screen?
- Assessments may be different across different patients depending on areas of concern

■ Use of other measures/tests

- Aim to get a “bigger picture” in order to guide approach to plan of care and interventions

Common Outcome Measures

- Activities-Specific Balance Confidence Scale
- Berg Balance Scale
- 30-Second Chair Stand
- Dynamic Gait Index
- Four Square Step Test
- 4-Stage Balance Test
- Functional Gait Assessment
- Gait Speed
- Mini-Balance Evaluation Systems Test
- Senior Fitness Test
- Short Physical Performance Battery
- Timed Up and Go

Senior Fitness Test

- Valid, reliable age-based outcomes assessment for older adults ages 60-94
- Uses 6 areas measured:
 - Lower body strength and flexibility
 - Upper body strength and flexibility
 - Agility/dynamic balance
 - Cardiovascular endurance

<https://tinyurl.com/seniorfit701>

Berg Balance Scale

- 14-item objective measure to assess balance and fall risk in adults
 - Max score of 56
 - Lower score = greater risk for falls
 - Berg 1992 states score <45 indicates greater risk of falling
 - Shumway-Cook 1997 found scores predictive of falls to be:
 - <51 and history of falls
 - <42 and no history of falls

<https://tinyurl.com/berg701>

Physical Activity for All Adults

■ Aerobic Recommendations:

150 minutes of moderate activity OR 75 minutes of vigorous activity OR Equivalent combination of both every week

■ Strengthening Recommendations:

- 2 or more days every week

■ Balance Recommendations:

- 2-3 days every week

Physical Activity for All Adults

Light Activity 3 METs	Moderate Activity 3 - 6 METs	Vigorous Activity > 6 METs
< 3.5 kcal/min	3.5 to 7 kcal/min	> 7 kcal/min
<ul style="list-style-type: none"> • Walking at 2 mph • Shopping • Fishing • Housework (dusting, washing dishes) • Ironing • Knitting • Mowing the lawn (riding mower) 	<ul style="list-style-type: none"> • Walking at a moderate or brisk pace of 3 to 4.5 mph on a level surface inside or outside • Bicycling 5 to 9 mph, level terrain, few hills • Softball • Shooting baskets • Recreational swimming • Yoga 	<ul style="list-style-type: none"> • Race walking and aerobic walking — 5 mph or faster • Jogging or running • Bicycling more than 10 mph or bicycling on a steep uphill terrain • Football game • Basketball game • Tennis match • Swimming Laps

Considerations for Older Adults

- Importance of multicomponent programs
 - combine aerobic, strengthening, and balance exercises
- Physical Activity Modifications
 - Chronic conditions may affect ability to participate
- Benefits
 - Lower risk of chronic conditions, improved cognition, improved quality of life, weight loss, lower risk of falls and related injuries, and MANY, MANY MORE!



QUESTIONS?

Helen Buchanan

helen_buchanan@med.unc.edu



References

- Centers for Disease Control and Prevention. STEADI - Older Adult Fall Prevention. 2019. Available at: <https://www.cdc.gov/steady/index.html>. Accessed January 13, 2020.
- Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. *J. Am. Geriatr. Soc.* 2011;59(1):148-157. doi:10.1111/j.1532-5415.2010.03234.x.
- Bergen G, Stevens MR, Burns ER. Falls and Fall Injuries Among Adults Aged ≥ 65 Years - United States, 2014. *MMWR Morb Mortal Wkly Rep.* 2016;65(37):993-998. doi:10.15585/mmwr.mm6537a2.
- Brown M. The physiology of age-related and lifestyle-related decline. In: *Geriatric Physical Therapy*. Elsevier; 2012:27-37. doi:10.1016/B978-0-323-02948-3.00012-2.
- Payton OD, Poland JL. Aging process. Implications for clinical practice. *Phys. Ther.* 1983;63(1):41-48. doi:10.1093/ptj/63.1.41.
- Lewis CB, Knortz KA. Neuromuscular Considerations. In: *Orthopaedic Assessment And Treatment Of The Geriatric Patient*. 1st ed. St. Louis: Mosby; 1993:25-42.
- Bone Density Test, Osteoporosis Screening & T-score Interpretation. Available at: <https://www.nof.org/patients/diagnosis-information/bone-density-examtesting/>. Accessed March 22, 2020.
- LeBlanc AD, Evans HJ, Schneider VS, Wendt RE, Hedrick TD. Changes in intervertebral disc cross-sectional area with bed rest and space flight. *Spine (Phila. Pa. 1976)*. 1994;19(7):812-817. doi:10.1097/00007632-199404000-00015.
- Jiricka MK. Activity tolerance and fatigue. In: Porth CM, Matfin G, eds. *Pathophysiology: Concepts Of Altered Health States*. 8th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams and Wilkins; 2009.

References

- Jbabdi M, Boissy P, Hamel M. Assessing control of postural stability in community-living older adults using performance-based limits of stability. *BMC Geriatr*. 2008;8:8. Published 2008 Mar 31. doi:10.1186/1471-2318-8-8.
- Zecevic AA, Salmoni AW, Speechley M, Vandervoort AA. Defining a fall and reasons for falling: comparisons among the views of seniors, health care providers, and the research literature. *Gerontologist* 2006;46(3):367-376. doi:10.1093/geront/46.3.367.
- Deshpande N, Metter EJ, Lauretani F, Bandinelli S, Ferrucci L. Interpreting fear of falling in the elderly: what do we need to consider? *J Geriatr Phys Ther* 2009;32(3):91-96. doi:10.1519/00139143-200932030-00002.
- Fritz S, Lusardi M. White paper: “walking speed: the sixth vital sign”. *J Geriatr Phys Ther* 2009;32(2):46-49. doi:10.1519/00139143-200932020-00002.
- Jones CJ, Rikli RE. Measuring functional fitness of older adults. *The Journal on Active Aging* 2002;1:24-30.
- Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst. Rev.* 2012;(9):CD007146. doi:10.1002/14651858.CD007146.pub3.
- Shirley Ryan Ability Lab. Berg Balance Scale. 2013. Available at: <https://www.sralab.org/rehabilitation-measures/berg-balance-scale#older-adults-and-geriatric-care>. Accessed January 14, 2020.
- Berg K, Wood-Dauphinee S, Williams JI, Maki, B. (1992). Measuring balance in the elderly: validation of an instrument. *Can. J. Pub. Health* July/August supplement 2:S7-11.
- Shumway-Cook, A., Baldwin, M., et al. (1997). Predicting the probability for falls in community-dwelling older adults. *Physical Therapy* 77(8): 812-819.
- Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for americans. *JAMA* 2018;320(19):2020-2028. doi:10.1001/jama.2018.14854.