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Exercise Prescription for Osteoporosis

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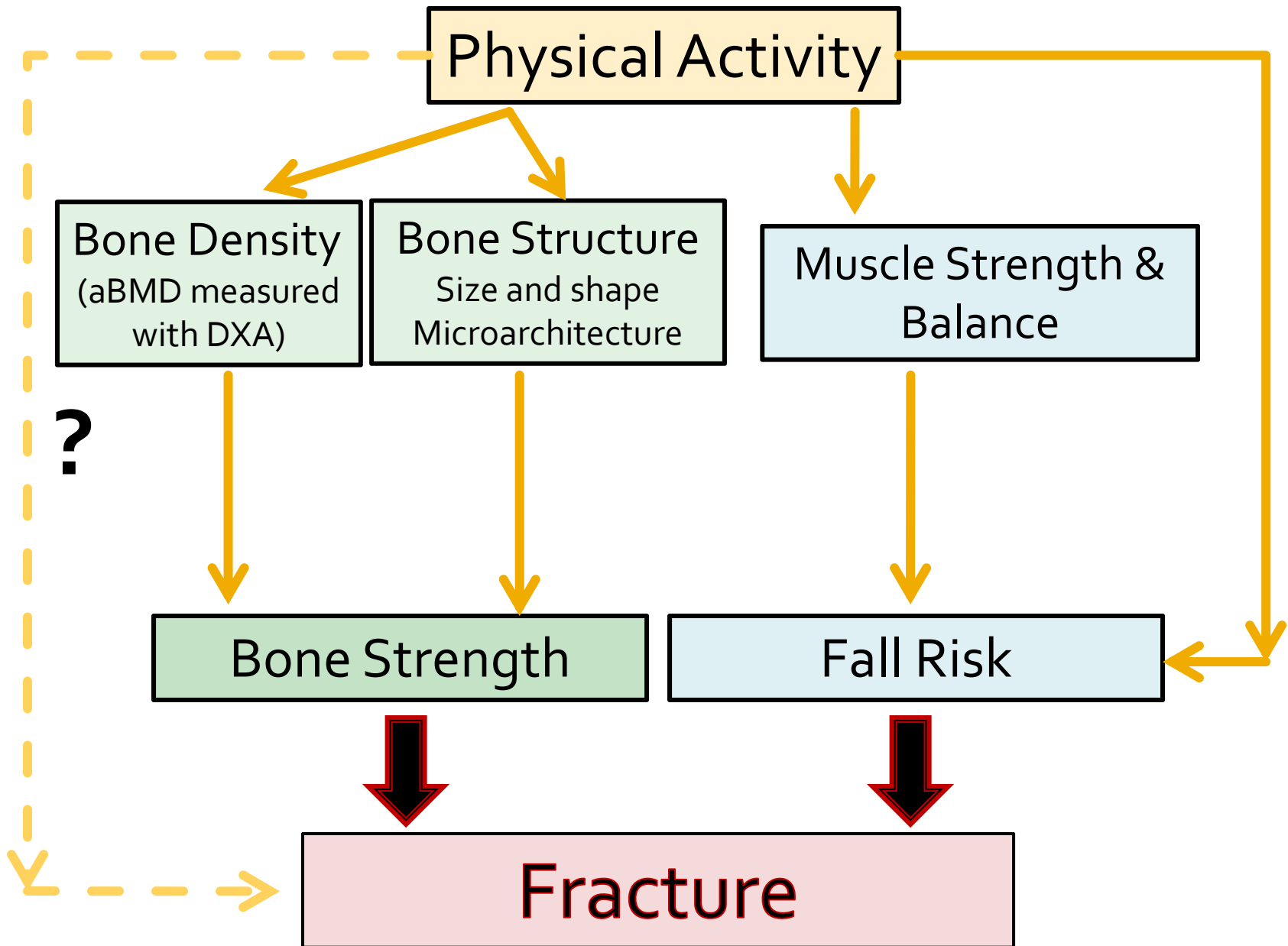
Exercise Prescription for Osteoporosis

Dr. Lora Giangregorio

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Objectives:

- To review the evidence supporting the use of exercise in individuals with osteoporosis or fractures
- To provide practical exercise recommendations for individuals with osteoporosis or fragility fractures



Physical changes and hip fracture risk

Factors predictive of risk for hip fracture, independent of aBMD^{1,2} include

- ◆ Slower gait speed
- ◆ Difficulty performing heel-to-toe walk
- ◆ Reduced visual acuity
- ◆ Inability to rise from a chair without using arms for support³

1. Dargent-Molina P, et al. *Lancet* 1996;**348**:145-149.
2. Dargent-Molina P, et al. *Osteoporos Int* 1999;**9**:188-192.
3. Cummings SR, et al. *N Engl J Med* 1995;**332**:767-773.

Fall Prevention

Interventions likely to be beneficial:

- Health/environmental risk factor screening/intervention
- Muscle strengthening and balance retraining
- Home hazard assessment and modification
- Vitamin D supplementation
- Withdrawal of psychotropic medication
- Tai Chi group exercise intervention

Fall Prevention with Exercise

- **17%** less likely to fall if participating in exercise
- Greatest effects – **42%** less likely to fall – in programs that:
 - Had **>50** hours over trial period (3-20 months)
 - Included challenging balance exercises
 - Did not include a walking program

Exercise for Fall Prevention

WHAT DOES IT MEAN?

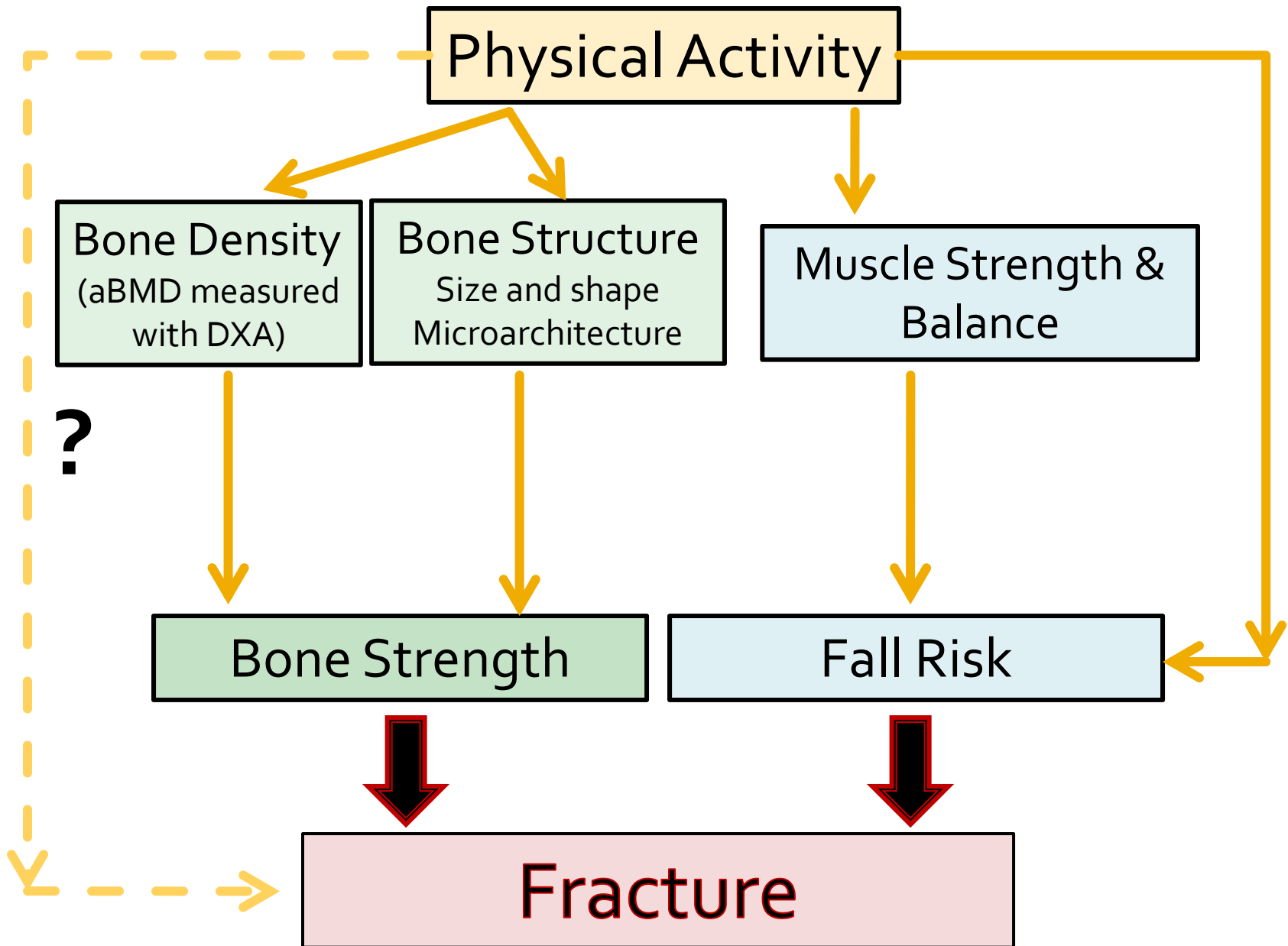
- Need to exercise regularly ($\geq 2x/\text{week}$)
- Need to perform challenging balance exercises
- Walking isn't enough!



Heel toe walking – no support

- ❶ Stand up tall and look ahead
- ❷ Place one foot directly in front of the other so they form a straight line
- ❸ Place the foot behind directly in front
- ❹ Repeat for 10 more steps
- ❺ Turn around
- ❻ Repeat the exercise

Otago Exercise Program



APPLIED LOAD

BONE STRENGTH

FRACTURE RISK

**STRUCTURAL
PROPERTIES**

Geometry

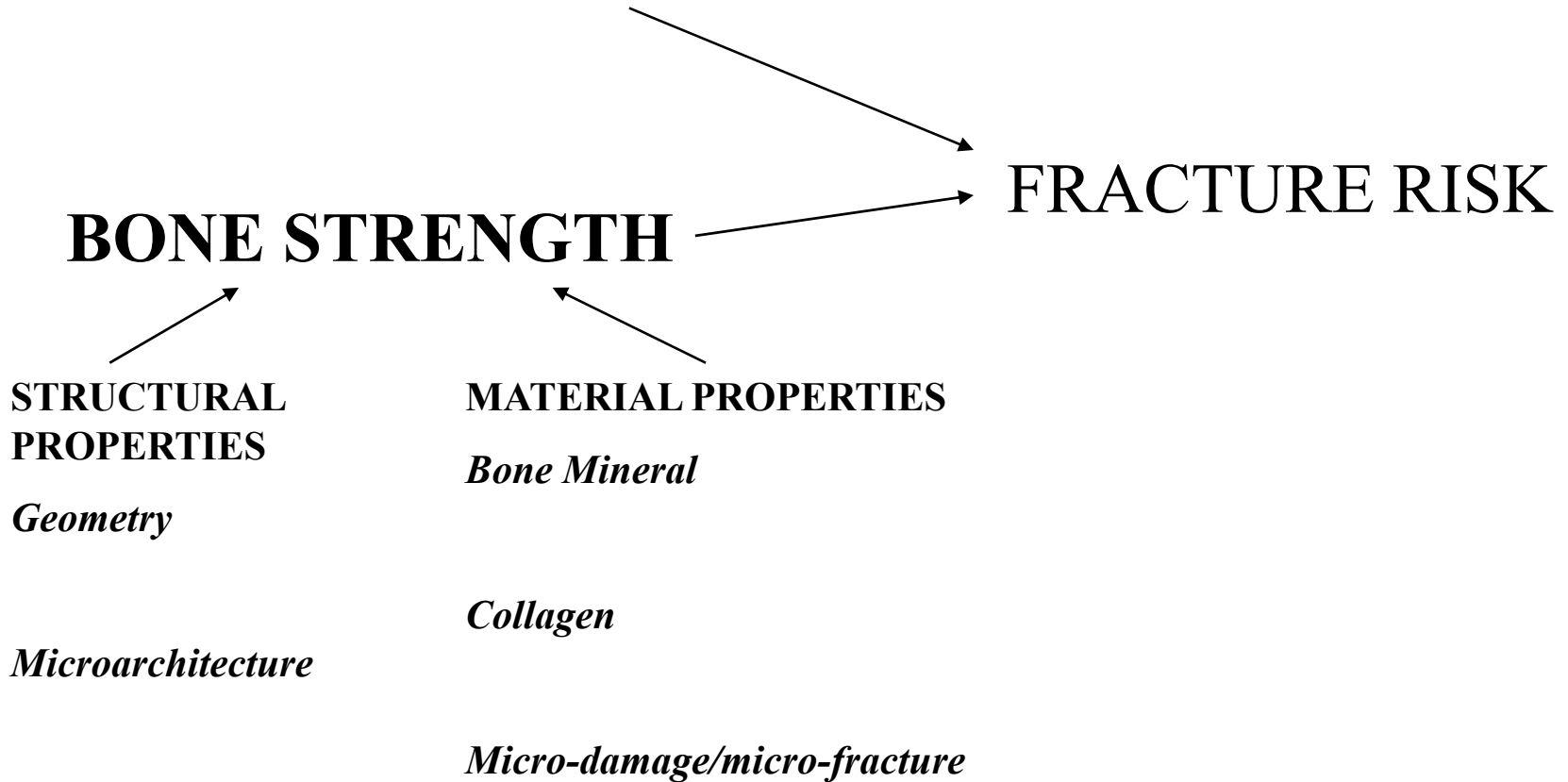
Microarchitecture

MATERIAL PROPERTIES

Bone Mineral

Collagen

Micro-damage/micro-fracture



Fracture Risk Assessment

New Guidelines Determine
10-year fracture risk based on:

- Bone density: aBMD g/cm^2
- Risk factors:
 - prior fragility fracture
 - oral glucocorticoid use
 - age
 - gender

Dual-energy x-ray absorptiometry
(DXA)

Impact of Exercise on aBMD

Physical activity during growth:

- Transition childhood → adolescence is critical period for bone mineral accrual
- ↑ BMD 1-6% with weight-bearing exercise before puberty, 0.3%-2% in adolescence
- Initiated before puberty, variable patterns, higher impact, short, frequent bouts
- Can it be maintained?

Impact of Exercise on aBMD

Premenopausal women

- high-intensity progressive RT ↑ lumbar spine aBMD
- high-impact training results in ↑ femoral neck BMD.

Prospective studies (18) of exercise in postmenopausal women:

- RT may ↑ lumbar spine aBMD ~1-2.5%
- Contradictory findings for hip aBMD
- Little effect of walking or endurance training
- Low- to mod-impact exercises + RT and/or agility training may preserve aBMD at hip and spine

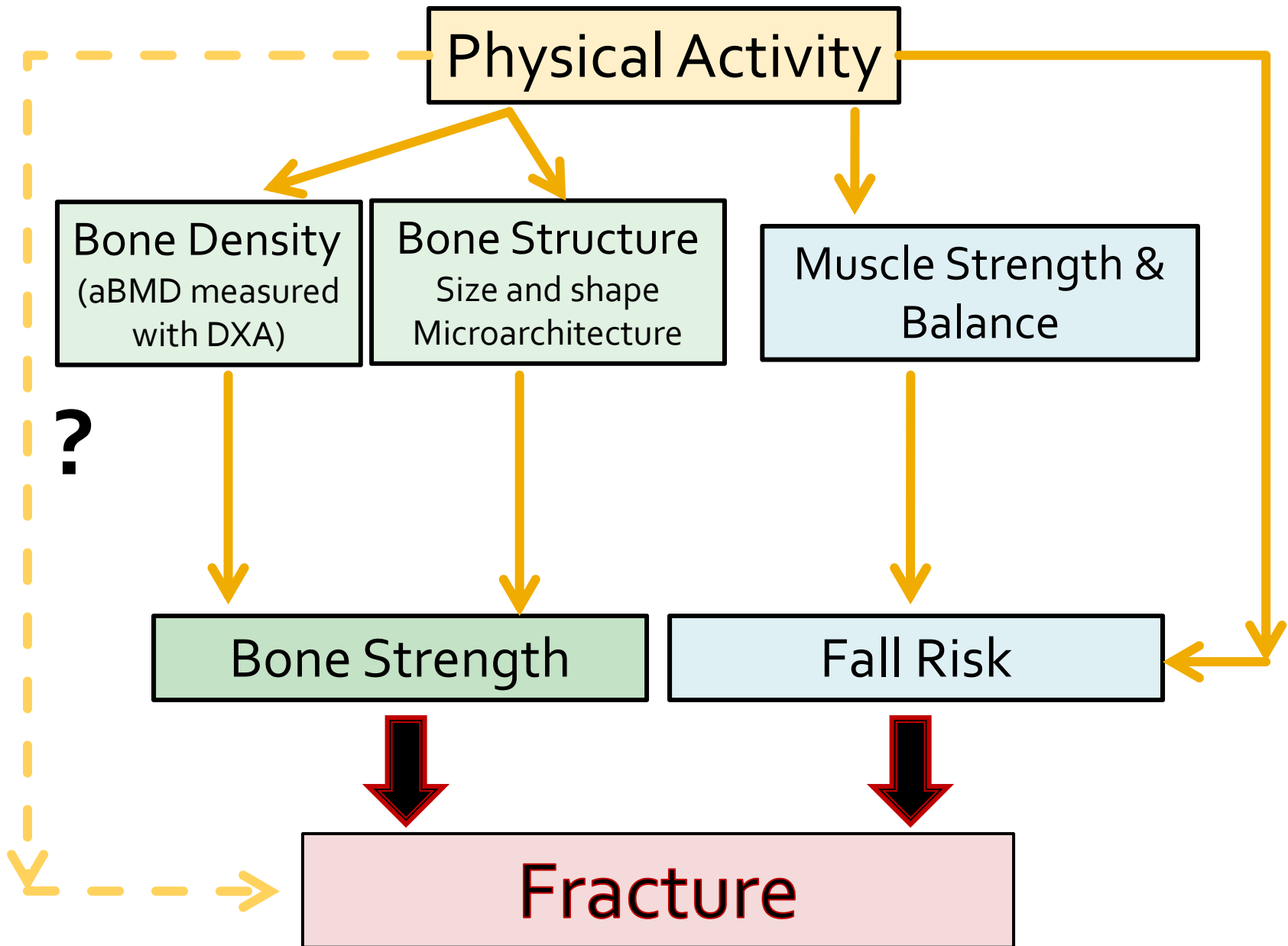
Mechanical Loading Characteristics that are Good for Bone

Animal Studies:

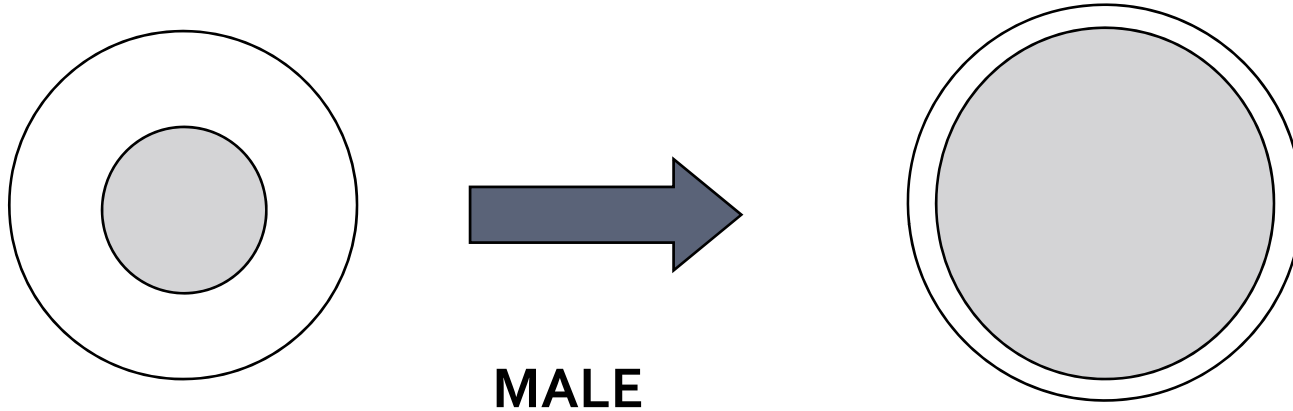
- Magnitude of loading – bigger is better
- Loading frequency – higher frequency better
- Dynamic loading – better than static
- Short duration of loading – short bouts better

How to target exercise to increase bone density (aBMD)

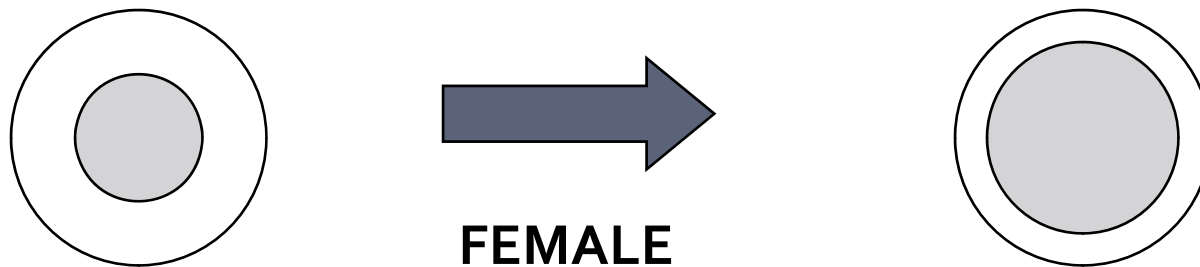
- ✓ Start young – exercise has greatest effect during growth
- ✓ Select exercises that are dynamic, moderate-high impact and multidirectional loading
- ✓ Exercise briefly, yet often
- ✓ Continue exercising as you age – exercise may prevent bone loss, and can maintain or improve muscle mass, improve balance and reduce fall risk



Age-related bone changes

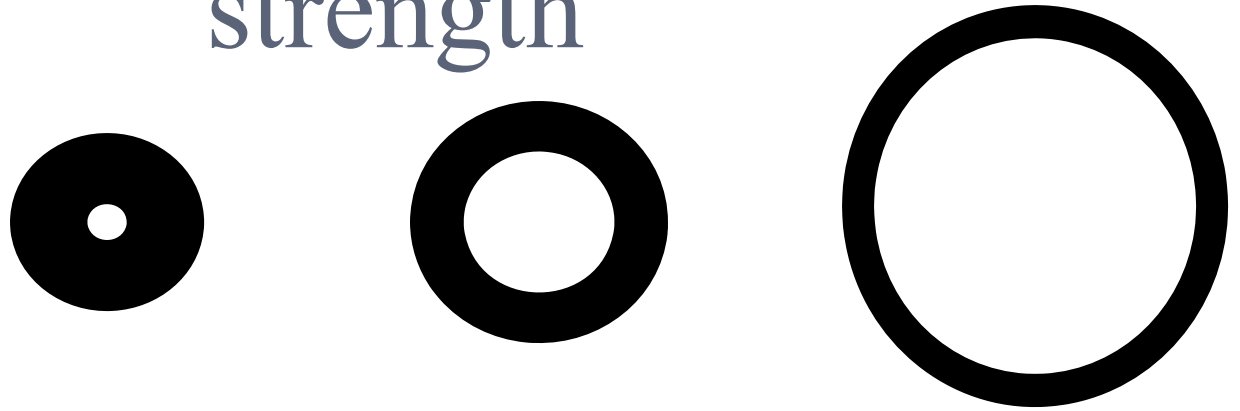


- Cortical thinning
- Compensatory increase in outer circumference



- Cortical thinning with porosity

Effect of geometry on long bone strength



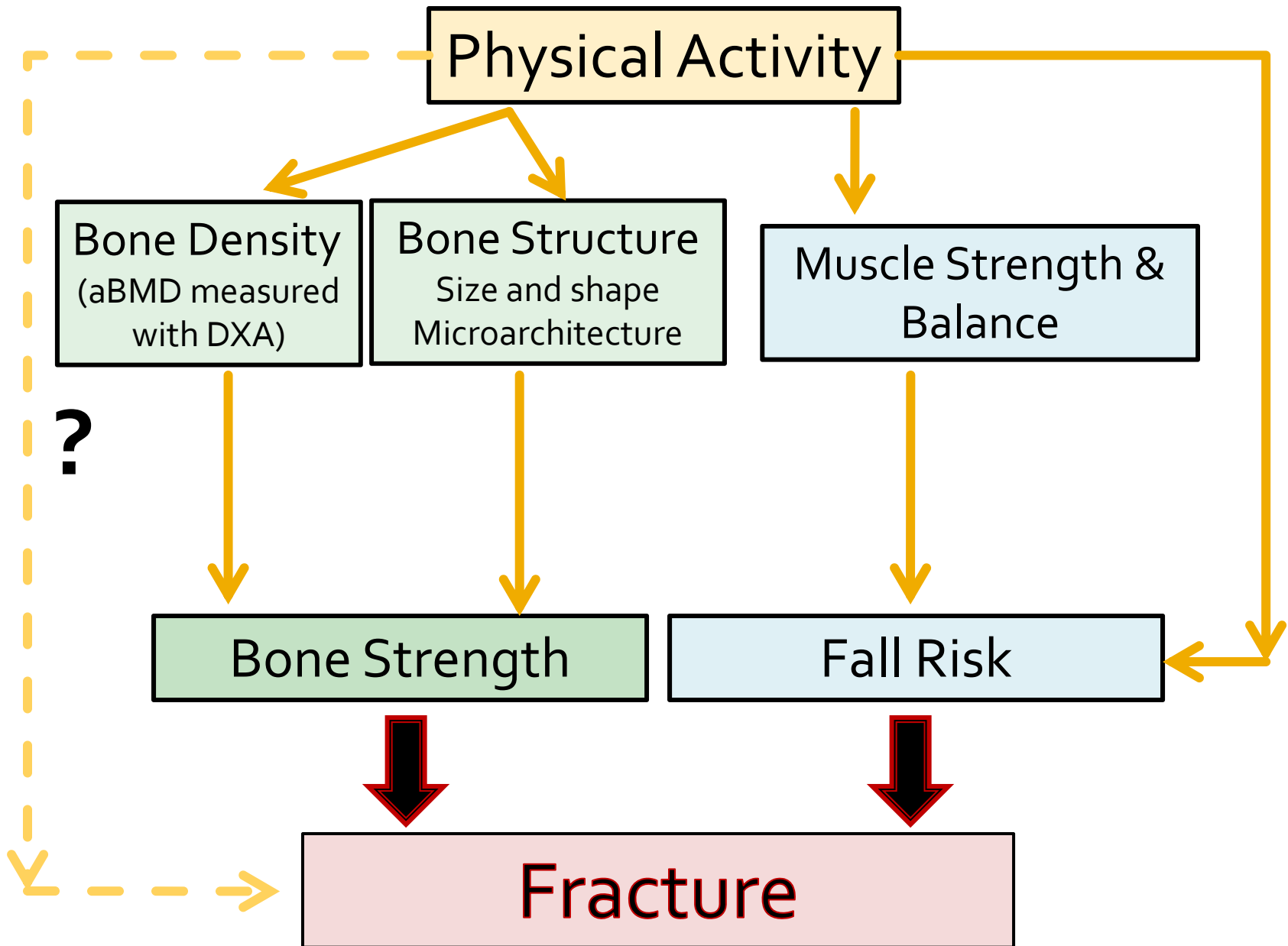
Areal BMD	1.0	1.0	1.0
Bending Strength	1.0	4.0	8.0
Axial Strength	1.0	1.7	2.3

Physical activity
may have an
important impact
on bone structure
that may not be
measurable on bone
density scans.

Impact of Exercise on Bone Structure

- Site-specific changes
- ↑ cortical area and diameter
- ↑ cortical density

recall
what
happens
when
loading is
reduced



Does exercise prevent fractures?

Picture removed

Prone back extension exercise with a pillow under the abdomen.

Sinaki et al 1982, Gold et al 2004, Hongo et al 2007

- Evaluated participants in a 2 yr study of back exercise 8 yrs after study cessation.
- Exercise group < 1/2 as many fractures as control
- However, loss to follow-up limit conclusions

Does exercise prevent fractures?

- Trial of home exercise in 46 women with ≥ 1 fracture
- No significant difference between groups was detected \rightarrow small sample size OR no effect?

Impact of Exercise on Pain, Function and QOL

After Vertebral Fracture and Hip Fracture

Exercise After Hip Fracture

Improved mobility with intensive, supervised ongoing exercise/therapy

- **Improved walking velocity** (0.23m/s, CI 0.05-0.41), (0.23 m/s, CI 0.05-0.4)
- **Less need of walking aid** (RR 0.62, CI 0.39-0.98)
- **Physical Performance Test** (5.7, CI 2.74 to 8.66)
- **Stair climbing** (-7.8s, CI -15.14 to -0.46)
- Leg ext. strength, fear of falling, balance

Exercise After Hip Fracture

Characteristics of Two Positive Trials

- 3x/wk for 12 weeks, 6MO
- Supervised in an outpatient centre, machines
- Progressive RT at 70-90% or 65% max
- Functional training – walking, stepping, balance activities

Exercise After Hip Fracture

More recent work:

- Higher intensity, weight-bearing exercise not better than lower intensity seated or lying exercises for mobility and balance* Moseley et al 2009
- ↑ muscle strength and power with 2x/wk supervised RT for 12 wks Portegijs et al 2008
- Arm ergometry + inpatient rehab improved aerobic fitness, mobility and balance Mendelsohn et al 2008

Exercise After Vertebral Fracture

- Review of literature to date:
 - Nature of “best exercises” unclear
 - Improvements in back extension strength, psychological symptoms, QOL
 - May improve balance
 - Improvements in pain in one study only

Gold et al, 2004, Malmros et al 1998, Papaioannou et al, 2003, Webber et al 2003, Hongo et al 2007

Exercise After Vertebral Fracture

Characteristics of 4 Positive Trials

- Balance training, muscle strengthening and stretching in lying, sitting, standing positions
- Focus is on trunk weakness, leg strength flexibility (ext), erect posture
- 2-3x/week supervised exercise program
- Self-maintenance may not be effective without some contact/supervision

Exercise after Fracture

Adverse Events

- Fractures (rib, metatarsal)
- Soft tissue injury (bruised ankle)
- Muscle soreness, fatigue
- Chest pain
- Pain – programs altered or ceased
- Fall concerns
- Unable or unwilling to complete testing

Prescribing Exercise for Individuals at Risk of Fractures

Practical Tips for Clinicians

**In a person
with
osteoporosis
some
movements
should be
avoided**



Practical Tips for Clinicians

What the evidence suggests:

- Supervised, patient-specific assessment and intervention
- Focus on:
 - Trunk endurance and extremity strength
 - Postural correction/erect posture
 - Weight-bearing exercises, unusual loading patterns
 - Balance training
 - 2-3x/week

Practical Tips for Clinicians

My top 5 for individuals with osteoporosis:

- Lower extremity strengthening - Sit to stand or squats (armchair, pillows if needed)
- Thoracic & lumbar extension
- Mid-back posture correction
- Balance training, including unusual loading
- ≥ 20 min+ of moderate intensity cardiovascular exercise 3x/week

Combined with:

- Postural correction and safe movement to reduce abnormal spine loading during all activities

Lower Extremity Strengthening

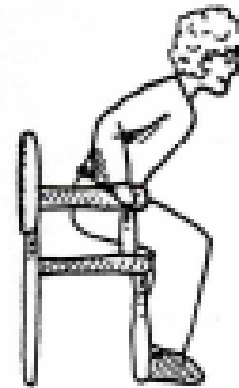
Sit to stand or Squat

Modifications:

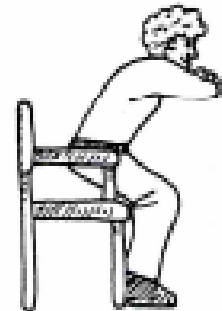
- Use of arms
- Pillow
- Use of chair against wall, remove chair
- Weights

Others: step up, lunge, leg flexion/extension

BEGINNER



PROGRESSION



Prone Back Extension Exercise

Somewhat evidence-based, but is it practical?

Back extension exercise in a prone position with a pillow under the abdomen.

Sinaki et al 1982, Gold et al 2004, Hongo et al 2007



- Hyperextension of spine = excessive compression
- Single leg extension = Activate lumbar ext + acceptable spine loading
- Bird-dog ↑ lumbar and thoracic extensor muscle challenge
- Avoid “hip hiking”, twisting or lateral flexion of spine
- Emphasize abdominal bracing



Good Form



Poor Form



- Emphasis is endurance → isometric holds 7-8 sec, increasing the number of times the hold is repeated rather than the duration, with short relaxation (<1min) in between.
- 3-5 holds per side, increasing as endurance improves

Postural Correction and Extension



- Pull in chin, relax shoulders
- Squeeze shoulder blades together to bring head back towards wall
- Maintain this position – push heel into wall one leg at a time
- Activates paraspinals and hip extensors and works on balance in single limb stance
- Can also incorporate thoracic extension while standing against wall

N. MacIntyre

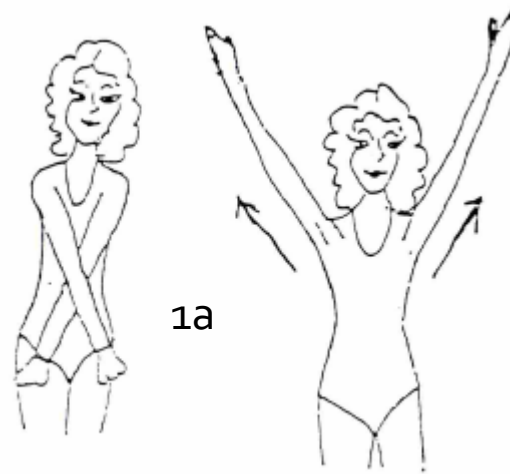
Posture Training

"V" exercise (1)
"W" exercise (2)

Can be performed in seated or standing to work lats and rhomboids

a = no resistance

b = using elastic resistance band



Balance Training

Static
Standing with
both legs



Reduce/alter base of support

one-legged stand, toe/heel stands,
tandem stance

Reduce contact with support object

Wall or chair

Reduce other sensory input (vision)

Toe raises – no support

- Stand up tall and look ahead
- The feet are shoulder-width apart
- Come back onto the heels, raising the front foot off the floor
- Lower the feet to the ground
- Repeat this exercise 20 times

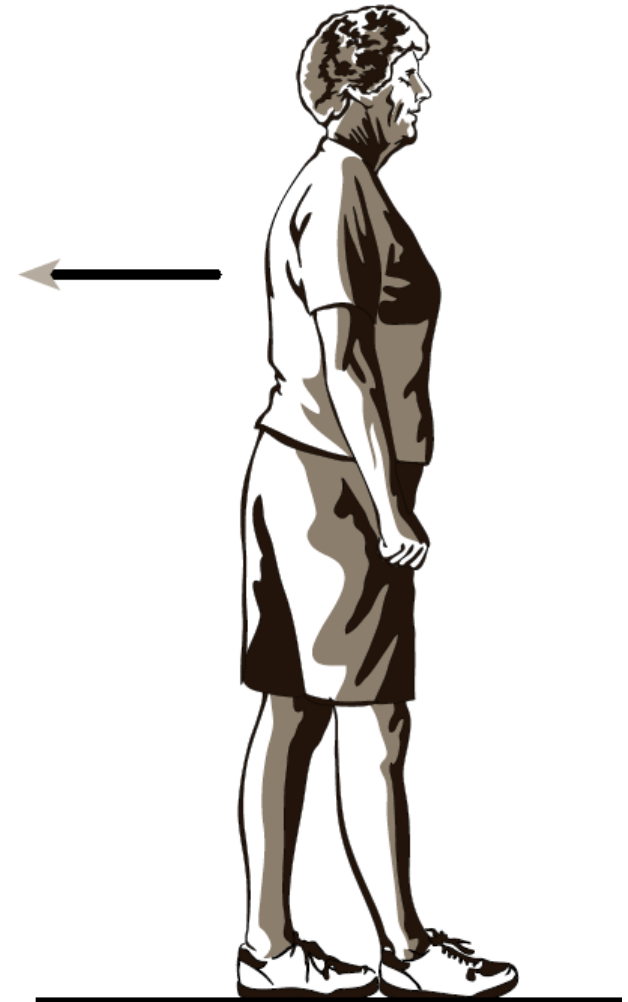
Balance Training

Perform **dynamic** movements that perturb COM and stress muscles important for posture (with or without support object)

- Tandem walk
- Heel walking, Toe walking
- Figure 8s
- Side Stepping
- Walking backwards



- Reduce contact with support object
- Perform task backwards



Other exercises

- Chin tucks
- Wall arch
- Wall push up, modified floor pushups
- Biceps, triceps, shoulder raises
- Hip flexion and extension, clam exercise

Muscle Strengthening

ACSM Recommendations for Older Adults:

- Resistance training for 2-3 days a week
- All major muscle groups - extremities & trunk
- 2-3 sets of each exercise
- Moderate to vigorous intensity (5-8 on 0-10 scale)
- Standing exercises with free weights may simultaneously train balance

Abdominal exercises

- Often avoided → flexion and compression
- Choose **isometric** exercises or pelvic tilts
- Emphasize spine stabilization & endurance
- Modify traditional isometric ab exercises by performing against wall
- Requires proper training for good form



Picture removed

Safe Movements

- Health professional's guide to rehab in patient with osteoporosis
 - Guidelines for safe movement
 - Body mechanics
 - Hip strengthening exercises

Practical Tips for Clinicians

Considerations for Enhancing Exercise Participation:

- Expert supervision/monitoring to enhance adherence & efficacy, enable progression
- Educate re: pain and fears
- Advocacy: cost, transportation



Isometric strengthening of back extensors and shoulder girdle muscles

Thank You!

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