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Exercise Prescription for Osteoporosis

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Exercise Prescription for Osteoporosis

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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 Activity

Bone Density (aBMD measured with DXA)

Bone Structure
Size and shape Microarchitecture

Muscle Strength & Balance

Bone Strength

Fall Risk

Fracture
Factors predictive of risk for hip fracture, independent of aBMD\textsuperscript{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 support\textsuperscript{3}

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

Frick et al (2010) *JAGS*
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

Sherrington et al 2008
WHAT DOES IT MEAN?

- Need to exercise regularly (≥2x/week)
- Need to perform challenging balance exercises
- Walking isn’t enough!

Heel toe walking – no support

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

Otago Exercise Program
Bone Density (aBMD measured with DXA) → Bone Strength → Fracture
Bone Structure (Size and shape Microarchitecture) → Bone Strength → Fracture
Muscle Strength & Balance → Fall Risk → Fracture
APPLIED LOAD

BONE STRENGTH

FRACTURE RISK

STRUCTURAL PROPERTIES

MATERIAL PROPERTIES

Geometry

Bone Mineral

Collagen

Microarchitecture

Micro-damage/micro-fracture

Adapted from Felsenburg et al, 2005
New Guidelines Determine 10-year fracture risk based on:

- Bone density: aBMD g/cm²
- 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?

Nikander et al 2010, MacKelvie et al 2002
Impact of Exercise on aBMD

Premenopausal women
- high-intensity progressive RT \( \uparrow \) lumbar spine aBMD
- high-impact training results in \( \uparrow \) femoral neck BMD.

Prospective studies (18) of exercise in postmenopausal women:
- RT may \( \uparrow \) lumbar spine aBMD \( \sim 1-2.5\% \)
- 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

Bonaiuti et al 2002, Nikander et al 2010
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

Turner et al
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

Warden et al 2004
Bone Strength

Fall Risk

Fracture

Physical Activity

Bone Density
(aBMD measured with DXA)

Bone Structure
Size and shape Microarchitecture

Muscle Strength & Balance

?
Age-related bone changes

MALE
- Cortical thinning
- Compensatory increase in outer circumference

FEMALE
- Cortical thinning with porosity

Beck et al. 1992
### Effect of geometry on long bone strength

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Bouxein 2003
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

Does exercise prevent fractures?

Prone back extension exercise with a pillow under the abdomen.


- 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

Sinaki 2002
Does exercise prevent fractures?

- Trial of home exercise in 46 women with ≥ 1 fracture
- No significant difference between groups was detected ⇒ 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 (0.23 m/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

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
Prone Back Extension Exercise

Somewhat evidence-based, but is it practical?

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

• 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

McGill, 2004, Ultimate Back Fitness and Performance
• 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

McGill, 2004, Ultimate Back Fitness and Performance
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

http://www.therapilates.com/osteonews.html
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

K. Shipp
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

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

Otago Exercise Program
Other exercises

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

Bonner et al, 2003
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

Thank You!

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