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# OSTEOPOROSIS AND PILATES

Part 1

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**Kristy Demers**  
PT, DPT



Kristy is a licensed physical therapist and a certified Pilates instructor. Kristy received her Doctorate of Physical Therapy from Washington University in St. Louis in 2006, and prior to that she graduated with her B.S. in Motor Development and minor in Psychology from Texas A&M University. Kristy has primarily practiced in the orthopedic sector of physical therapy where she primarily specializes in treatment of musculoskeletal pain syndromes of the spine, pelvis and extremities. One of her areas of expertise is pregnancy and postpartum movement. Kristy is also a full-time Instructor in the Doctor of Physical Therapy program at The University of Saint Augustine in Austin Texas.

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## Goals of Presentation

- Define Osteoporosis and its significance.
- Discuss normal and abnormal bone physiology across a lifespan.
- Discuss preventative measures for osteoporosis and bone growth in childhood.
- Discuss changes in bone mass with aging.

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### Goals of Presentation

- Review types of exercises that will improve and/or help maintain bone health.
- Discuss risk factors and contraindications for individuals with osteoporosis.
- Discuss exercise prescription for individuals with osteoporosis.

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### Osteoporosis

- Osteoporosis: means “porous bone”
  - Osteo – “bone” & Porosis – “porous condition”
- Disease of the bones. Osteoporosis occurs when you lose too much or make too little bone.
- Most common sites: Hip, spine, and distal forearm/wrist
- Thus, bones become weak and may break from a minor fall or simple actions
  - Fragility Fracture

□ <http://npt.com/learn/boos>, accessed 9/30/13 Discover\*Move\*Inspire

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### Osteopenia

- **Osteopenia –**
  - Refers to bone mineral density (BMD) that is lower than normal peak BMD but not low enough to be classified as osteoporosis.
  - Indicates that individual is at greater risk for developing osteoporosis.

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### Facts: It is Common

- Nearly 60 % of adults > 50 y/o are at risk of breaking a bone and should be concerned about their bone health.
- 1 in 2 women and up to 1 in 4 men age 50 and older will break a bone due to osteoporosis.
- Rate of death for a hip fracture is the same for Breast CA
- <http://www.iofbonehealth.org/facts-statistics>, accessed 9/30/13

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### Facts: It is Serious

- 20% of seniors who break a hip will die within 1 year of fracture from problems related to the broken bone itself or surgery to repair it.
- 80% will not return to prior functional level and many will need long-term nursing home care.
- A prior fracture is associated with an 86% increased risk of another fracture (4x the risk of another fx)
- <http://nof.org/articles/7>, accessed 9/30/13

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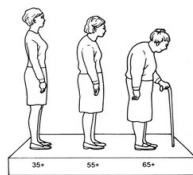
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### Symptoms

- Often called the “**silent disease**”
- First sign/symptom is often a **Fracture**
  - Most common: Hip, spine and distal forearm/wrist
  - Fracture often occurs more easily than expected

Other signs include:

- **Loss of height**
- **Stooped posture**
- **Excessive thoracic kyphosis**
  - - Dowager’s Hump
- <http://nof.org/articles/7>, accessed 9/30/13



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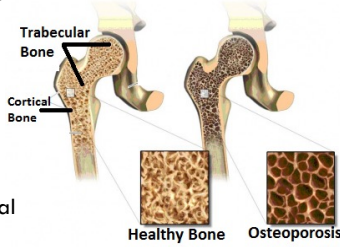
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### Most Common Sites

- Spine – Thoracic and Upper Lumbar
- Femoral neck/Hip
- Distal Forearm/Wrist
- Higher % of Trabecular vs Cortical Bone



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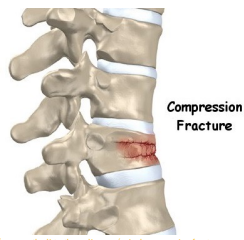
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### Vertebral Fractures

- Collapse at anterior aspect of vertebra.
- Worsened with flexion
- Minimal to Severe back pain
- 70-80% of compression fractures are asymptomatic
- Loss of height
- Stooped posture and protruding abdomen



<http://www.orthostorboneplus.com/what-compression-fractures>

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### Osteoporosis defined

- **Osteoporosis** : A bone mineral density value (T Score) that is **-2.5 SD or more below** the mean peak value in young adult woman.
- **Osteopenia**: T score: **-1.0 to -2.5 SB below** the mean peak value in young adult woman.
- **Normal**: T score at or above **-1.0 SD below** the mean peak value in young adult woman.

<http://www.americanbonehealth.org/what-you-should-know/about-t-scores>

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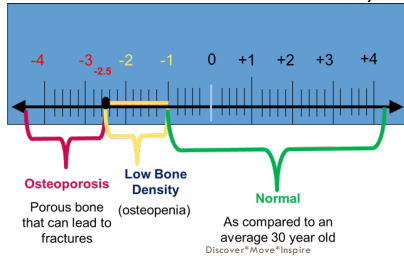
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### T Score Values

A T-score is found on a bone density report (Dual Energy X-Ray Absorptiometry or DXA Scan) and shows how much one's bone mass varies from the bone mass of a healthy 30 y/o.



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### Causes and Risk Factors

Osteoporosis occurs when the body fails to form enough new bone, when too much existing bone is reabsorbed, or both.

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### Causes and Risk Factors

- Low bone mass development as a youth.
  - The higher your peak bone mass as a youth, the less likely you are to develop Osteoporosis as you age.
- Family history and Genetics
  - Caucasian/Asian woman more likely.
- Decreased calcium and vitamin D intake
- Drop in estrogen and testosterone

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### Causes and Risk Factors, Cont'd

- ❑ Prolonged bed rest
- ❑ Certain medical conditions
- ❑ Certain medicines
- ❑ Absence of menstrual periods (**amenorrhea**) for long periods of time
- ❑ Drinking a large amount of alcohol
- ❑ Large consumption of caffeine and soft drinks.
- ❑ Low body weight
- ❑ Smoking

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### Normal Bone Physiology: Bone Remodeling

Bone is a living dynamic organ, it is constantly changing- replacing old bone with new.

#### Bone Remodeling Cycle:

1. Resorption: **Osteoclasts** remove old bone.
2. Reversal: Mononuclear cells appear on the bone surface
3. Formation: **Osteoblasts** lay down new bone

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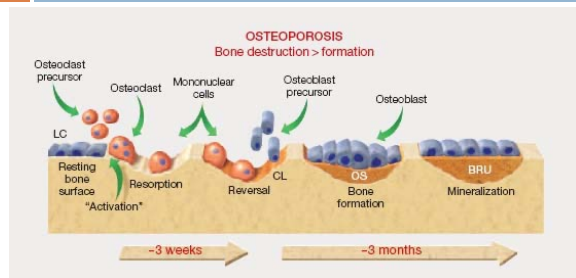
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### Bone Remodeling Cycle



<https://www.medicinesonline.com/2011/05/osteoporosis-and-osteoporthritis-bone-is-the-common-battle-ground/>

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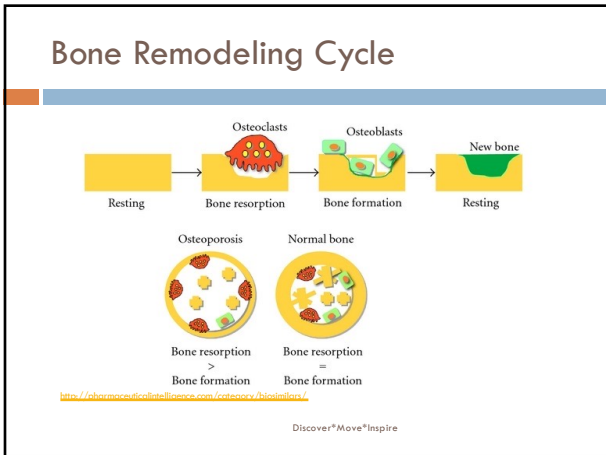
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### Wolff's Law

- **Wolff's Law states:**
  - Bone grows and remodels in response to the forces that are placed upon it.
  - If loading increases, the bone will remodel itself over time to become stronger.
  - However, if loading decreases, the bone will become weaker due to turnover
- Frost, HM (1994). "Wolff's Law and bone's structural adaptations to mechanical usage: an overview for clinicians". *The Angle Orthodontist* 64 (3): 175-188. PMID: 8060014
- Stedman's Medical Dictionary

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### Wolff's Law: Examples

- The racquet-holding arm bones of tennis players become much stronger than the other arm.
- Surfers who knee-paddle frequently develop bone bumps on the their tibial eminence.
- Astronauts who spend a long time in space will often return to earth with weaker bones.
- Weightlifters often display increases in bone density in response to their training.
- Martial artists display increases in bone density in the areas of bone they use to strike objects.

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## Mechanical Loading

- Exercises that produce **high impact** or strains that are **not performed as part of every day activities** (jumping) may be more effective in improving bone strength than repetitious activities (walking, running, swimming).
- Our **bodies can get used to normal activities**, and activities that the body is not used to are more effective for bone health.

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# OSTEOPOROSIS AND PILATES

Part 2: Prevention

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## Osteoporosis: Prevention

Exercise and training for the prevention of Osteoporosis.

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### Childhood: The Bone Building Years

- It's never too early to invest in bone health. The **prevention** of osteoporosis begins with optimal bone growth and development in **youth**.
- It's estimated **a 10% increase of peak bone mass in children reduces the risk of an osteoporotic fracture during adult life by 50%**.

□ <http://www.iqbonehealth.org/prevention-osteoporosis>, accessed 10/8/13

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### Childhood: The Bone Building Years

- BMD in females increases 4% per year during puberty.
- Girls 11.5-13.5 y/o **gain 26% of their adult bone mineral content**. This equals the amount lost during post-menopausal years.
  - Girls need to be hitting it hard between 11-14!

Burrows, M. Exercise and bone mineral accrual in children and adolescents. Journal of Sports Science and Medicine (2007) 6, 305-312.

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### Peak Bone Mass and Aging

- **Peak bone mass (PBM) is achieved by 30.**
  - 90% of PBM is acquired by 18 in girls and 20 in boys
  - Between late adolescent and 30, osteoclastic and osteoblastic activity is EVEN = No Net Gain or Loss
- After 30, **woman lose 1-3% BM/yr** and men lose .3-1%/yr
- That amounts to woman **losing 30-50% PBM** and men losing 20-30% PBM with aging alone.

□ U.S. Department of Health and Human Services. Bone Health and Osteoporosis: A Report of the Surgeon General. Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General, 2004.

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## Menopause

- Bone mass loss associated with menopause has been reported to average 12% of a woman's entire bone mass.
- Direct relationship between reduced estrogen levels and increased bone loss.
- Menopause can trigger fast and furious bone loss.

Recker RR. The elusive concept of bone quality. Curr Osteoporosis Rep. 2004;2(3):97-100.

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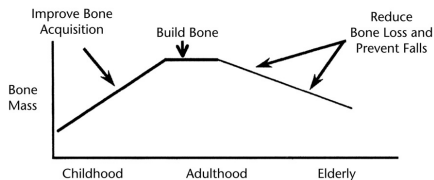
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## So what can we do???

**Exercise!!!!**

Timing of Exercise can affect bone density and prevent osteoporosis and falls.



Perry SB, Downey PA. Fracture Risk and Prevention: A Multidimensional Approach. PHYS THER 2012;92:164-176

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## Goals for prevention across the Lifespan

- **Childhood** – Improve bone growth
- **Adulthood** - Maintain age related bone loss and build bone if able.
- **Elderly** – Minimize bone loss and improve balance and reduce fall risk

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## Childhood: Improve Bone Growth

### Principles of Exercise to produce an Osteogenic response:

1. Exercise must be at a **high intensity** to overload the skeletal system beyond normal conditions in order to stimulate a response;
2. Exercise must be **novel** in order to stress bone in ways that are new and different from normal daily activities
3. Exercise effects must be **site specific**.

Perry SB, Downey PA. Fracture Risk and Prevention: A Multidimensional Approach. PHYS THER 2012;92:164-178

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## Childhood: Activities that have the best influence on skeletal development

### High-intensity weight bearing activities

- ▣ Gymnastics
- ▣ Ballet
- ▣ Soccer/agility
- ▣ Pilates?
- ▣ Lots of JUMPING!!!

Verses

### Low-intensity

- ▣ Walking
- ▣ Swimming



<http://jimmiesfield.com/wp-content/uploads/2011/10/NCGA-Rings.jpg>

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## Childhood: Improve Bone Growth

▣ **Prevention** is the best defense against Osteoporosis and that begins with physical activity in **childhood**.

▣ **Higher bone mass** is achieved in **active children** compared to inactive children.

▣ Siemenda, C.W., Miller, J.Z., Hui, S.L., Reister, T.K. & Johnston, C.C. 1991. Role of physical activity in the development of skeletal mass in children. *J. Bone Miner. Res.*, 6(1): 1227-1233.

▣ Exercise-induced bone mass gains and structural adaptations in early childhood **can be maintained** through puberty and into adulthood.

▣ Gunter K. Physical activity in childhood may be the key to optimizing lifespan skeletal health. *Exercise and sport sciences reviews*. 2012;40(1):13-21

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## Adulthood: Maintain and Build

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**GOAL: Minimize age-related bone loss and improve bone growth if able**

- Most woman are unaware of their bone density status.
- Remember after 30 y/o woman lose 1-2% of BMD each year.

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## Adulthood: Best Exercise for Prevention

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- **Weight Bearing Exercises:**
  - Jumping, Hoping, Standing, Kneeling, Quadruped, Upper Body Weight Bearing
  - Bones strengthen in response to forces it has to resist- including body weight and gravity.
  - Need to “load” the bone beyond normal forces
  - Study: Bailey et al: 50 multidirectional hops performed daily showed a 1.8% increase in femoral neck BMD

□ Bailey CA, Brooke-Wavell K. Optimum frequency of exercise for bone health: Randomized controlled trial of a high-impact unilateral intervention. *Bone*. 2010;44(1):1043-1049.

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## Adulthood: Best Exercise for Prevention

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- **High-Intensity Progressive Resistance Training**
  - Resistance from weights, bands, springs, body weight.
  - Increases strength of bone by muscles pulling on the bones to create tension and load.
  - Best Formula for bone strengthening is: weight-bearing + resistance training.
- **Quick movements and agility drills**
  - “Bone Confusion”

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### Adulthood: Best Exercise for Prevention

□ **Postural and spinal stability exercises**

- Decompression to unload the anterior vertebral bodies

□ **Balance and Proprioception training**

□ **Jogging/Aerobic exercise**

- 20-30 min 3x/week increased lumbar spine BMD by 1% (Snow-Harter 1992)

No benefits have been found with walking at normal speed or swimming.

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### Elderly: Minimize Bone Loss

**Prevention Based Exercise Program for Elderly:**

- Minimize rate of bone loss
- Improve balance and reduce fall risk
- Improve muscle strength, endurance and flexibility
- Improve postural alignment and stability.

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### Key Aspects for a Prevention Based Pilates Program

□ Integrate **weight bearing exercises**

- Standing on floor, wall, seated/standing on chair
- Hands and knees exercises, Planks, Push-ups

□ Combination of **weight bearing** and **resistance exercises**

- Ex. Springs, elastic bands, weights, body weight

□ Integrate **High-Impact Exercises:**

- Ex. Jump board

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### Key Aspects for a Prevention Based Pilates Program

- Add **novel/unfamiliar** exercises/movements
  - ▣ Progress as able in pilates program
- Include sufficient **back, hip and wrist** strengthening.
  - ▣ Exercise must be site specific
  - ▣ Spinal, hip, scapulothoracic, and upper body stability training.

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### Key Aspects for a Prevention Based Pilates Program

- Emphasis on **upper thoracic extension**
  - ▣ Not extension at lumbar spine
- Include **Balance** and **Proprioception** training
- Address **posture** and **alignment**
- Teach **control, precision, and form**

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## OSTEOPOROSIS AND PILATES

Part 3

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**Osteoporosis: Safety and Maintenance**

Exercise prescription for the osteoporotic and elderly client

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**Osteoporosis - Review**

- Disease of the bones. Osteoporosis occurs when you lose too much or make too little bone.
  - Most common sites: Hip/femoral neck, spine, and distal forearm/wrist
- Bones become weak and may break from a minor fall or simple actions: Fragility Fracture
- **Osteoporosis** : A bone mineral density value (T Score) that is **-2.5 SD or more below** the mean peak value in young adult woman.
  - <http://infoform/learn/boots>, accessed 9/30/13

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**Osteopenia - Review**

- Refers to bone mineral density (BMD) that is lower than normal peak BMD but not low enough to be classified as osteoporosis.
- Indicates that individual is at greater risk for developing osteoporosis.
- **Osteopenia**: T score: **-1.0 to -2.5 SB below** the mean peak value in young adult woman.

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### Bone Mineral Density and Aging

- Peak bone mass (PBM) is achieved by 30.
- After 30, woman lose 1-3% BM/yr and men lose .3-1%/yr
- Menopause can trigger fast and furious bone loss.

□ U.S. Department of Health and Human Services. Bone Health and Osteoporosis: A Report of the Surgeon General. Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General, 2004.

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### Bone Mineral Density beyond Menopause

- Direct relationship between reduced estrogen levels and increased bone loss.
- BMD will decrease with inactivity
- Exercise even without an increase in BMD can reduce the occurrence of vertebral fractures, improve balance, and decrease the risk of falls.

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### Risk Factors Reviewed

Caution should be taken with anyone that shows risk factors of Osteoporosis:

- Woman over the age of 50
- Low body weight and thin frame <126 lbs and BMI <20 kg/m<sup>2</sup>
- Family history of Osteoporosis and/or fragility fractures
- Increased thoracic kyphosis

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### Risk Factors Reviewed

Caution should be taken with any one that shows risk factors of Osteoporosis:

- Prior history of broken bones
- Ethnicity: Caucasian and Asian
- Smoking, heavy alcohol use
- Certain diseases and medication.

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### Symptoms

- First sign/symptom is often a **Fracture**
  - Fracture often occurs more easily than expected: Fragility fracture
  - Severity of pain from fracture can vary
- Loss of height
- Stooped posture
- Excessive thoracic kyphosis

Discover\*Move\*Inspire <http://www.moveinspire.com/post-osteoporosis>

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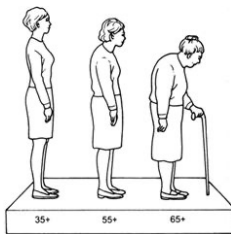
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### Postural Changes & Muscle Imbalances

- Tight hip flexors
- Weak hip extensors (gluts)
- Tight scapular protractors (pecs)
- Weak scapulothoracic muscles
- Tight extrinsic neck muscles (SCM)
- Weak deep cervical neck flexors



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## Exercise for the Osteoporotic and Elderly Client

### GOALS:

- Bone Health – Appropriate weight bearing and resistance training
- Flexibility - minimize thoracic kyphosis
- Muscle Strength and Endurance
- Core Stabilization
- Cardiovascular Fitness
- Gait Steadiness
- Balance training

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## Contraindications for the Osteoporotic Client

### 1. Spinal Flexion Movements

- Flexion is contraindicated because it loads the anterior portion, front, of the vertebral bodies increasing risk for fracture.
- Absolutely no Thoracic flexion; use caution with Lumbar and Cervical flexion.
- Unsafe exercises include: Roll-up, rolling like a ball, spine stretch forward, neck pull, seal, teaser, short spine, stomach massage round, etc
- Caution with exercises like: Bridge (no articulation)

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## Contraindications for the Osteoporotic Client

### Flexion vs. Extension

- Sinaki et al studied the effects of extension exercises, flexion exercises and no exercise in postmenopausal woman.
- Results: Percentage of woman with new vertebral fractures at follow-up by exercise group:
  - Spinal Extension: 16%
  - Spinal Flexion Exercises: 89%
  - Combined Spinal Extension and Flexion: 53%
  - No Exercise: 67%

Sinaki M, Mikkelson SA. Postmenopausal spinal osteoporosis: Flexion versus Extension exercise. Arch Phys Med Rehabil. 1984;65(10):593-596

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### Contraindications for the Osteoporotic Client

#### 2. Spinal rotation and side bending

- Also avoid combined flexion, side bending and rotation
  - ▣ Side bending and rotation should always emphasize lengthening of the spine.
  - ▣ Goal is to off-load the anterior portion of the vertebral body.
- Caution with exercises like: Mermaid, Short box: Side to side

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### Contraindications for the Osteoporotic Client

#### 3. Floor "crunch" movements

- Avoid lying abdominal exercises that involve bringing your torso or legs off the ground
- The pressure of the spine on the floor can cause small spinal fractures
- Exercises to Avoid/Modify: Hundred, abdominal series, etc

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### Contraindications for the Osteoporotic Client

#### 4. Jumping and Dynamic Weight Bearing Activities

- Avoid If T-Scores are 2.5 or lower.
- Avoid If prior spinal or hip fracture.
- Or if have any other signs of osteoporosis...

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### Important Considerations

- Understand/remember risk factors to minimize fracture in the “un-diagnosed” client
- Make sure osteoporotic client has MD clearance for exercise
- Make sure client understands contraindications and how to protect their spine from fracture

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### Goals with Pilates and Osteoporosis

- Focus on axial elongation and body awareness
- Improve spinal alignment and ability to align the spine with the pelvis, hips, legs, feet, shoulders and head
- Encourage safe thoracic spinal extension
- Teach proper breath and concentration

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### Goals with Pilates and Osteoporosis

- Teach proper body mechanics
  - ▣ Hip Hinge
- Strengthen and improve control of the deep spinal stabilizing muscles.
  - ▣ Avoid crunches and flexion
- Improve balance, proprioception and control
  - ▣ Reduce risk of falling

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### Caution with Traditional Classes

- Individuals with Osteoporosis should be encouraged to take privates or semi-private classes geared toward osteoporosis.
- ~Large % of pilates Mat exercises are contraindicated
  - Avoid flexion biased exercises, combined flexion with side bending or rotation exercises, and rolling exercises.

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### Healthy Movements

- Thoracic extension
- Chest and Rib Expansion
- Cervical Retraction
- Hip Extension and Flexion without spinal movement
- Encourage flexibility of the upper and lower extremities without spinal compensation

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### Safe positioning

- **Supine:** Keep head on ground (possibly a small towel roll under head or neck) – avoid spinal flexion.
- **Prone:** Place pillow under stomach if have large thoracic kyphosis.
- **Hands and Knees:** Good position, care with wrists.
- **Sitting and standing:** Avoid excessive thoracic kyphosis

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## Exercise Prescription Review

AGE	Best Exercise Intervention
Children	High- intensity weight bearing exercises: Jumping, Gymnastics, Ballet, agility training.
Adults: Pre-Menopausal	Weight bearing exercise, high intensity progressive resistance training, agility drills, postural and spinal stability exercises, balance and proprioception training, jogging/aerobic exercise.
Adults: Post-Menopausal	As above but consider T-score and risk factors. Thoracic extension biased exercises and balance training.
Adults: Elderly/Osteoporotic	Appropriate weight bearing and resistance training, thoracic extension biased exercises, proprioception and balance training, flexibility and posture training.

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