Cycling and Osteoporosis: Who, Why and Where?

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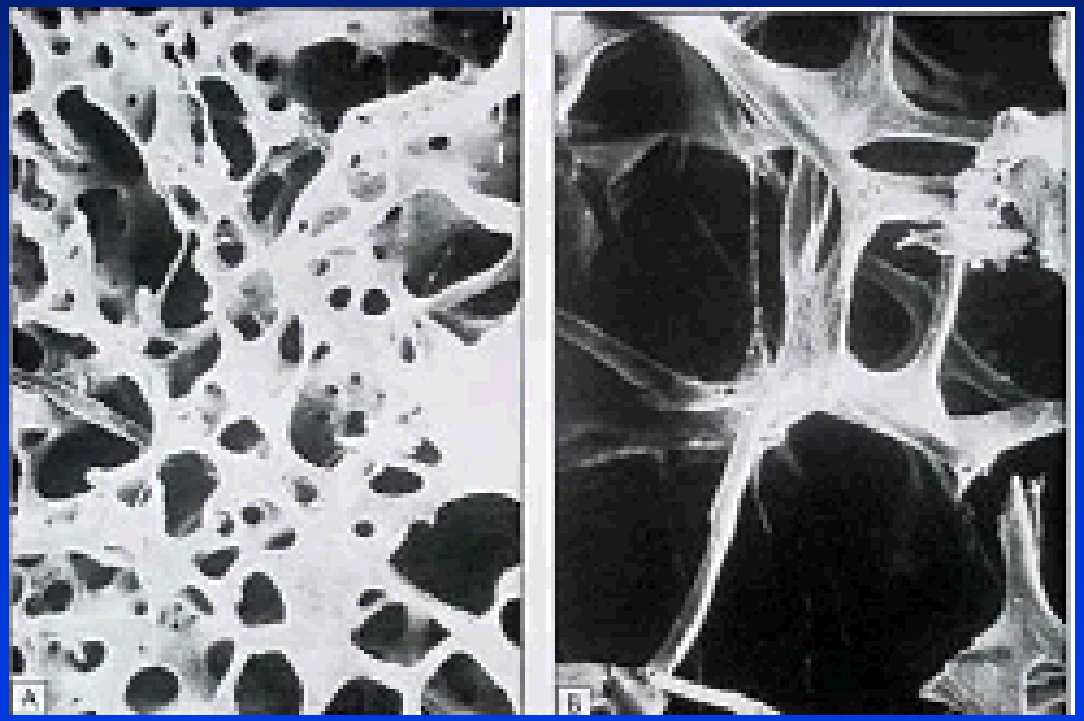
Outline

- What is skeletal fragility and how is it diagnosed?
- Do cyclists get skeletal fragility? Why?
- What can be done to prevent fractures in cyclists?

What is Osteoporosis?

- Loss of mineral and structural integrity with resulting fragility
- We can assess mineral content (bone mineral density), but not structural integrity



What About Trauma?

- Even non-osteoporotic bone will fracture with extreme trauma
- There is no threshold for skeletal fragility
- The stronger the bone the more trauma required to fracture…

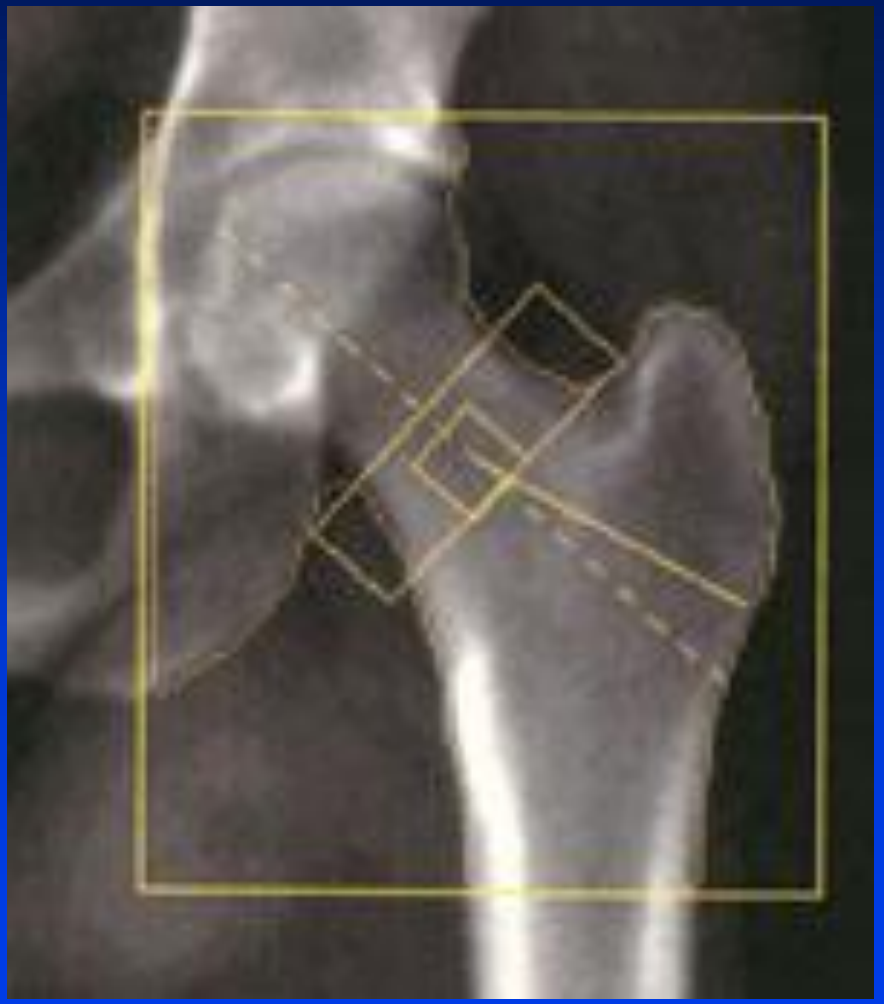
Can This Be Avoided?

- Devastating for professionals/teams
- Some fractures are inevitable, but many are not…
- Any increase in skeletal strength will reduce the overall risk of fracture

Traditional Risk Factors for Fracture

- The Big Three: age >50, lack of sex steroids, and Caucasian
- Other important risk factors
  - Previous fracture (especially hip or spine)
  - Inactivity (bedrest)
  - Thin
- Measurement of bone mineral density is the est predictor of fracture available

Bone Mineral Density (DXA)



Interpretation of DXA Scans

- Absolute mineral content (hip or spine) in gm/cm^2
- <50: relative to others your age and gender (standard deviations above or below = z-score)
- Each 0.1 gm/cm^2 decrease (about a SD) in BMD increases fracture risk 2-3 fold
  - No threshold

Who Should Have a DXA?

- Guidelines for general population
  - All women > 65, men >70
  - Postmenopausal with risk factors (fracture, family history, smoker, weight<127, certain meds
- No guidelines for athletes
  - Previous fracture(s), prolonged amenorrhea
- May not be covered by insurance but not expensive (Medicare pays $128)

Physical Activity and Bone?

Physical Activity: Good and Bad News

- Moderate weight-bearing exercise associate with higher BMD and fewer fractures in older men and women
- In premenopausal women, extreme exercise with amenorrhea associated with lower BMD
- What about competitive cyclists?
  - No studies of fracture risk
  - BMD?

BMD in Cyclists

- Multiple small cross-sectional studies
  - Consistently show 10-20% lower BMD in competitive cyclists compared to non-cyclists, runners or tri-athletes
- Both men and women, all skeletal sites (particularly hip and spine)
- Less apparent in mountain than road cyclists

Rector et al, Metabolism, 2008

Warner et al, Bone, 2002

Duncan et al, Med Sci Sports Exer, 2001

What About the Pros?

- 23 professional male cyclists (single undisclosed team)
  - Average age 28, 26% had previously fractured
  - Total body BMD measured at end of season
  - 65% were at least 1SD below average
  - Lowest in climbers, highest in time trialists (correlated with lean body mass)
- 30 professional cyclists
  - Hip BMD 18% lower than matched controls

Medelli et al, J Clin Densitometry, 2008
Campion et al, Int J Sports Med, 2010

Bone Loss Over Time in Cyclists

- Few data in cyclists, but young male runners and tri-athletes do not lose bone
- University of Colorado Study: 14 elite cyclists (mean age 34), multiple BMD measurements over 1 yr.
- Annual bone loss: 1% spine and 1.5% hip
  - No control group
  - Changes in weight not reported

Barry et al, JBMR, 2008

Potential Causes of Skeletal Fragility in Cyclists

- Genetic
- Sex hormone deficiency
- Calcium deficiency
- Weight loss
- Unloading

Sex Hormone Deficiency

- Key skeletal sex hormone in men and women is estradiol, not testosterone
- Women: amenorrhea should be avoided
- Men: most but not all studies show similar sex hormone levels in cyclists vs. others

Rector et al, J Strength Training Conditioning Res, 2009
Rector et al, Metabolism, 2008

Calcium (or Vitamin D) Deficiency

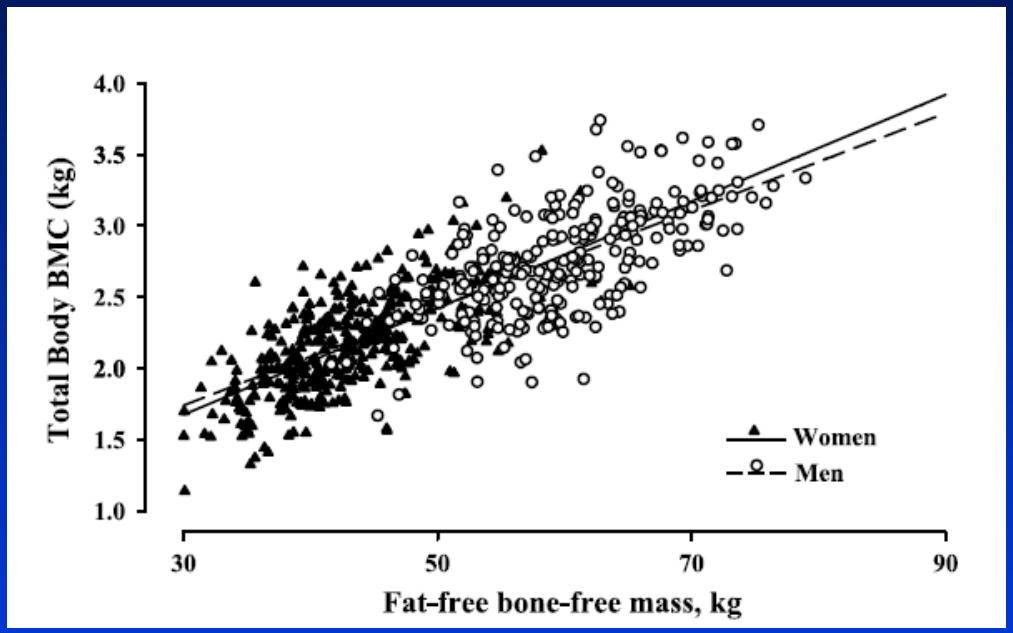
- Excessive calcium loss in perspiration could accelerate bone loss
- Greater transdermal calcium loss associated with lower BMD in some studies
- University of Colorado randomized trial over 1yr:
  - Similar bone loss over with calcium supplementation or placebo (1.5% per year both in groups)

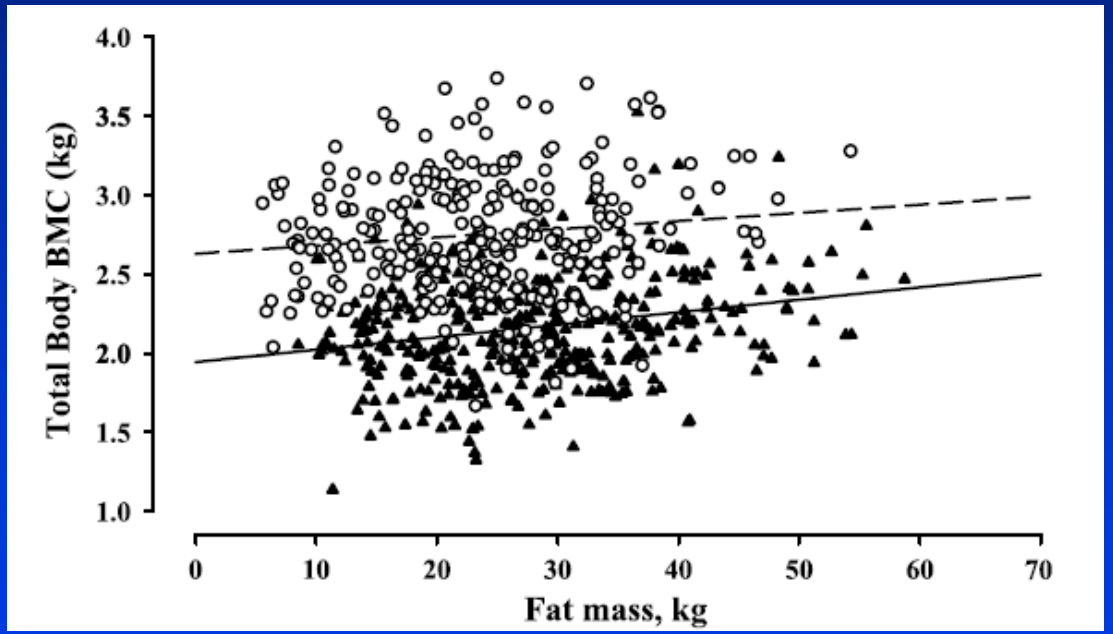
Barry et al, JBMR, 2008

Weight Loss

- Weight and BMI strongly predict BMD
- Both intentional and unintentional weight loss associated with increased bone loss
- Lean mass vs. fat mass?

Lean Mass vs. Fat Mass and BMD





Korht et al, Med Sci Sports Exer, 2009

Loss of LBM in Cyclists?

- No longitudinal data in cyclists correlating seasonal changes in lean or fat mass to bone loss
  - Bone loss over 1 yr. in CU study persisted after adjustment for changes in LBM
  - Suggests other mechanisms may be responsible

Unloading

- Inactivity (bed rest) results in rapid bone loss
- Despite your intuition, cycling does not load hip or lower leg
- Israeli study
  - 6 subjects with implanted tibial strain gage (!)
  - Average/max strain (tension, compression, shear)
  - Running>stepmaster>walking>cycling
  - Average shear running, cycling: 5027 vs. 628

Milgrom et al, J Bone Joint Surg, 2004

How to Prevent Fractures in Cyclists

- Rule number 1#: don't fall
- Identify athletes at high risk
  - Family, medical and fracture history
  - BMD of hip and spine
  - Judicious lab testing (e.g. vitamin D level)
- Interventions to reduce fracture risk…

Preventive Measure for Everyone

- Replete calcium/vitamin D
  - Typical supplement: 1000 mg Ca, 800 IU D_3
- Cross-training with high-impact activity
  - Run or jog
  - 50 hops each day for 6 mo. increased hip bone mass 2% in young women
- Avoid significant loss of lean body mass with diet and resistance exercise

Bailey et al, Bone, 2009

Specific Treatments for Osteoporosis

- Oral contraceptives for persistent amenorrhea
- Bisphosphonates (prevent bone resorption)
  - Extensively studied in older men women
  - Effective and safe (avoid pregnancy)
  - Consider if previous hip or spine fracture or very low BMD (2-3 SDs below average)

Summary and Conclusions

- Fractures occur when trauma > skeletal strength
  - No thresholds for trauma or skeletal strength
  - Increasing skeletal strength will reduce fracture risk even in those without osteoporosis
- Competitive cycling accelerates bone loss resulting in low bone mass, even in young men
- Highest risk: genetic predisposition, amenorrhea, loss of lean body mass, and inadequate weight-bearing activity

Summary and Conclusions 2

- BMD measurements are simple, safe and highly predictive. Monitoring feasible.
- Preventive measures: adequate Ca/D, high impact cross-training, avoid loss of LBM
- Pharmacologic therapy: no guidelines for athletes
- Bisphosphonates are treatment of choice for known osteoporosis
  - Use for spine/hip fracture or very low BMD
  - Avoid in childbearing age women

Avoid the Tour de Potholes…