Long chain polyunsaturated fatty acids and Bone health: An overview

Prof Marlena C Kruger
School of Food and Nutrition
College of Health
Massey University
New Zealand
• Essential fatty acid deficient animals develop severe osteoporosis plus renal and arterial calcification

• Various studies in humans and animals show that high levels of arachidonic acid in plasma phospholipids are associated with urinary loss of calcium, renal stone formation, bone loss, and periodontal disease

- Borland et al, 1931
- Alfin-Slater et al, 1958
- Buck et al, 1991
- Stêpánková et al, 1996
- Tulloch et al, 1994
- Schlemmer et al, 1998
- Requirand et al, 2000
- Baggio et al, 2000
Epidemiological evidence

Adults and post-menopausal women
Rancho Bernardo study

- Investigated association between ratio of dietary omega-6 to omega-3 fatty acids and BMD in 1532 community dwelling men and women aged 45-90y over 4 years

- Dietary data using FFQ’s
  - Significant inverse association between ratio of dietary LA and ALA and BMD at the hip
    - Independent of age, lifestyle and BMI
  - Increasing ratio of total dietary omega-6 to omega-3 FA significantly associated with lower BMD at the hip in all women

Weiss et al, 2005; Am J Clin Nutr 81: 934
Effect of seafood intake on total body and hip BMD in a rural Chinese population

Zalloua et al, 2006; Maturitas 56: 1

12,055 men and women aged 25 – 64 included
Groups III and IV pre- and postmenopausal women
• **NHANES 2005-2008**
  – Omega 3 dietary intake (g/day) and omega 3 supplement use were assessed from two 24 hour recalls in 2125 men and women > 60 years of age
  – Dietary omega 3 was marginally associated with increased femoral neck BMD but not total femur or spine BMD (Mangano et al, 2014; Osteoporosis Int 25: 1033)

• **Kuopio OSTPRE Fracture Prevention Study**
  – 554 women with mean age = 68 years
  – 3 day food record at baseline; BMD at lumbar spine, hip and whole body at baseline and 3y
  – A positive relationship found between dietary total PUFAs, intakes of linoleic acid and linolenic acid, and BMD at the lumbar spine and whole body – in women not using HRT at baseline (Jarninen et al, 2012; Eur J Clin Nutr 66: 496)
PUFAs and risk of fracture

- Few studies assessed relationship of fish/ fish oil consumption with risk of fractures
  - No relationship:
    - Case control study in 167 Spanish men and women > 65 years: no relationship between omega-3 intake and fragility fractures but risk of fracture was significantly elevated in those eating diets high in omega 6 (Martinez-Ramirez et al, 2007; Eur J Clin Nutr 61: 1114)
    - Framingham study including 522 P-M women and 352 men: No relationship between EPA and DHA intake and hip fracture (Farina et al, 2011; J Nutr 141: 1146)
  - Some relationship:
    - Women’s Health Initiative: In 137,486 women, intake of saturated fats associated with higher risk of hip fracture / highest omega 3 intake associated with lowest hip fracture rates
Issues?

- Not definitive
- Use dietary information at one time point only
- Use FFQ or 24 hour recall or three day recalls – no consistency in methods
- Several confounding factors to correct for
- Include a variety of ethnicities
Interventions

Adults and post-menopausal women


Out of 24 studies, only 10 were found to be credible with no or some effects.
Elderly women: Changes in Bone density over 36 months

Kruger et al, 1998; Ageing 10: 385
4g EPO/ 440mg fish oil +1g Ca versus 1g Ca/day; Changes in BMD for both age groups

Bassey et al., 2000; Brit J Nutr 83: 629
Interventions Cont’

• In post-menopausal women
  – the combination of aerobic exercise and 1g fish oil/day over 24 weeks resulted in reduction of bone resorption (CTX-1) and inflammatory markers (TNF, IL-6, PGE2) while raising 1,25 vitamin D levels and bone density (only in E and S group)
  – BMD, osteocalcin negatively correlated with TNF and PGE2.
    (Tartibian et al, 2011; Nutr Metab 8: 71)

  – An intake of 900mg omega 3/day had no effect on bone turnover over 6 months
    (Sharif et al, 2010)
Issues with the human intervention studies:

- Studies were relatively short in time
- Different population groups were used – is the response the same? Some studies fail to report racial/ethnic background of participants
- The response to PUFA is enhanced by addition of calcium, vitamin D status
- The source of omega 3 may be an issue. Some studies use ALA together with EPA and DHA or various ratios of EPA:DHA; these may have differential effects on bone
- Various placebos were used containing various amounts of saturated versus unsaturated fat which also may impact inflammation, calcium absorption, bone turnover and BMD
In summary:

• In adults and older women:
  – Higher intakes of saturated fat and omega 6 FA associated with lower bone density
  – Higher intakes of omega 3 associated with lower risk for hip/ all fractures
  – Some support for improvement of BMD over time in elderly women

• Dose required? Between 1-3g total omega 3 / day; ~ 600mg DHA and EPA per day
  – Not confirmed in intervention trials – further long term trials required
Thank you