Results

Objective 1

* In gymnastics dummy variable for all results (pvals, estimate)
* Gymnastics has a significant effect (p-values < 0.05)
* Effects are most prominent in the forearm and hip regions
* All of forearm, 4/6 hip, 0/1 spine, 0/1 subhead
  + a lot of variation in subhead -> whole body measurement, not precise measure of what we are interested in
* These results make sense physically
  + Previous studies have shown … about certain hip measurements
* Interpret results as being in gymnastics increases forearm measurements by (# to #) standard deviations

Rivadeneira, F., Zillikens, M. C., De Laet, C. E., Hofman, A., Uitterlinden, A. G., Beck, T. J. and Pols, H. A. (2007), Femoral Neck BMD Is a Strong Predictor of Hip Fracture Susceptibility in Elderly Men and Women Because It Detects Cortical Bone Instability: The Rotterdam Study. J Bone Miner Res, 22: 1781–1790. doi:10.1359/jbmr.070712

Buckling ratio measures stability – the lower the measure the more stable an individual is

Higher BR -> increase in fracture risk

Higher narrow neck width leads to increase in fracture risk

Thinning cortices leads to increase in fracture risk

[J Bone Miner Res.](https://www.ncbi.nlm.nih.gov/pubmed/18684092) 2008 Dec;23(12):1892-904. doi: 10.1359/jbmr.080802.

**Prediction of incident hip fracture risk by femur geometry variables measured by hip structural analysis in the study of osteoporotic fractures.**

[Kaptoge S](https://www.ncbi.nlm.nih.gov/pubmed/?term=Kaptoge%20S%5BAuthor%5D&cauthor=true&cauthor_uid=18684092)1, [Beck TJ](https://www.ncbi.nlm.nih.gov/pubmed/?term=Beck%20TJ%5BAuthor%5D&cauthor=true&cauthor_uid=18684092), [Reeve J](https://www.ncbi.nlm.nih.gov/pubmed/?term=Reeve%20J%5BAuthor%5D&cauthor=true&cauthor_uid=18684092), [Stone KL](https://www.ncbi.nlm.nih.gov/pubmed/?term=Stone%20KL%5BAuthor%5D&cauthor=true&cauthor_uid=18684092), [Hillier TA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Hillier%20TA%5BAuthor%5D&cauthor=true&cauthor_uid=18684092), [Cauley JA](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cauley%20JA%5BAuthor%5D&cauthor=true&cauthor_uid=18684092" \t "_blank), [Cummings SR](https://www.ncbi.nlm.nih.gov/pubmed/?term=Cummings%20SR%5BAuthor%5D&cauthor=true&cauthor_uid=18684092).

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**Abstract**

The role of bone tissue's geometric distribution in hip fracture risk requires full evaluation in large population-based datasets. We tested whether section modulus, a geometric index of bending strength, predicted hip fracture better than BMD. Among 7474 women from the Study of Osteoporotic Fractures (SOF) with hip DXA scans at baseline, there were 635 incident hip fractures recorded over 13 yr. Hip structural analysis software was used to derive variables from the DXA scans at the narrow neck (NN), intertrochanter (IT), and shaft (S) regions. Associations of derived structural variables with hip fracture were assessed using Cox proportional hazard modeling. Hip fracture prediction was assessed using the C-index concordance statistic. **Incident hip fracture cases had larger neck-shaft angles, larger subperiosteal and estimated endosteal diameters, greater distances from lateral cortical margin to center of mass (lateral distance), and higher estimated buckling ratios (p < 0.0001 for each).**Areal BMD, cross-sectional area, cross-sectional moment of inertia, section modulus, estimated cortical thickness, and centroid position were all lower in hip fracture cases (p < 0.044). In hip fracture prediction using NN region parameters, estimated cortical thickness, areal BMD, and estimated buckling ratio were equivalent (C-index = 0.72; 95% CI, 0.70, 0.74), but section modulus performed less well (C-index = 0.61; 95% CI, 0.58, 0.63; p < 0.0001 for difference). In multivariable models combining hip structural analysis variables and age, effects of bone dimensions (i.e., lateral distance, subperiosteal diameter, and estimated endosteal width) were interchangeable, whereas age and neck-shaft angle were independent predictors. Several parsimonious multivariable models that were prognostically equivalent for the NN region were obtained combining a measure of width, a measure of mass, age, and neck-shaft angle (BMD is a ratio of mass to width in the NN region; C-index = 0.77; 95% CI, 0.75, 0.79). Trochanteric fractures were best predicted by analysis of the IT region. Because section modulus failed to predict hip fracture risk as well as areal BMD, the thinner cortices and wider bones among those who fractured may imply that simple failure in bending is not the usual event in fracture. Fracture might require initiation (e.g., by localized crushing or buckling of the lateral cortex).

Objective 2:

PERIPOST In to PERIPOST Quit

* Only two significant differences
  + Ultra-distal bmc and ultra-distal structural strength
  + Strong strong evidence
* Quitting does not change your bone development path that much (minimal attenuation)
  + Still see benefits even after quitting

POST quit to PERI quit

* One significant difference
  + Distal Radius modulus
* Not that important when you quit– gymnastics is still beneficial

PERI quit to NON never

* 7/14 significant differences
  + All pointing in direction we expect
* Compared to those who were never in gymnastics, females still see benefits after they quit (even if quit early)
  + Note that we’re comparing those who quit early to those never in

Regardless of whether you quit early or late, there’s still a gymnastics benefit. The effect size may be smaller, but still significant benefits for gymnastics.

PERI in to NON never

* 8/14 significant differences
* Even after removing those who quit late, many beneficial effects of gymnastics

Objective 3: