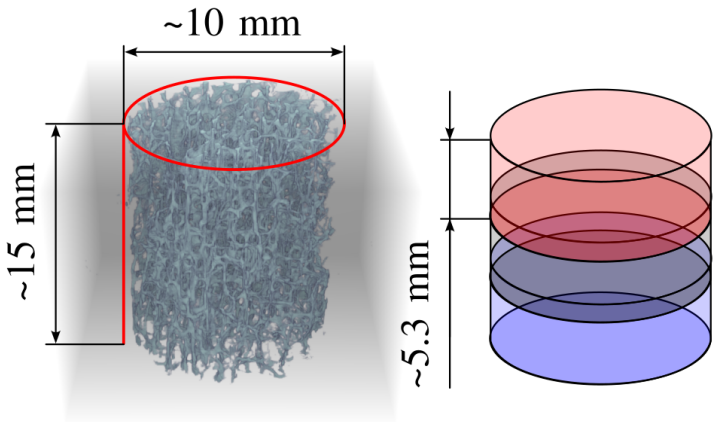
UNIVERSITÄT BERN

Fabric-Elasticity Relationships in Healthy and Diabetic Individuals

Mathieu Simon

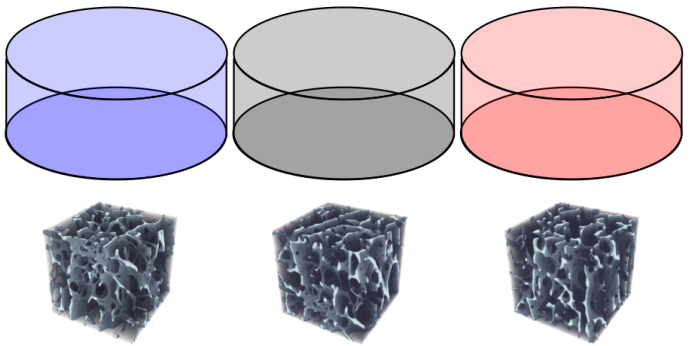
March 3, 2025

Samples



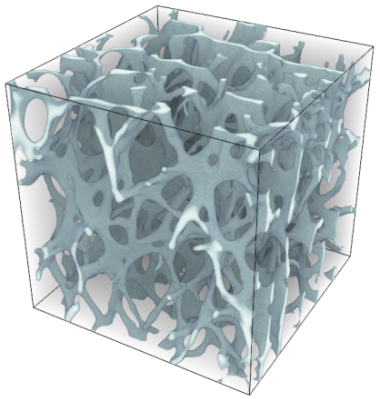
84 Samples
29 Distal femur (26 Ctrl + 1 T2D)
57 Femoral Head (28 Ctrl + 29 T2D)

3 Stacks

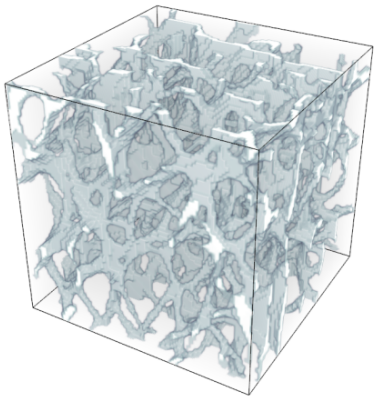


1 Cubic region of interest (ROI) per stack

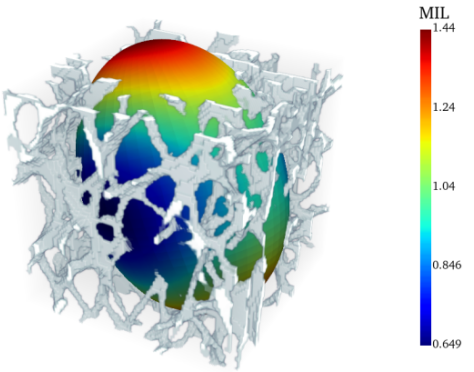
Medtool 4.8



252 ROIs

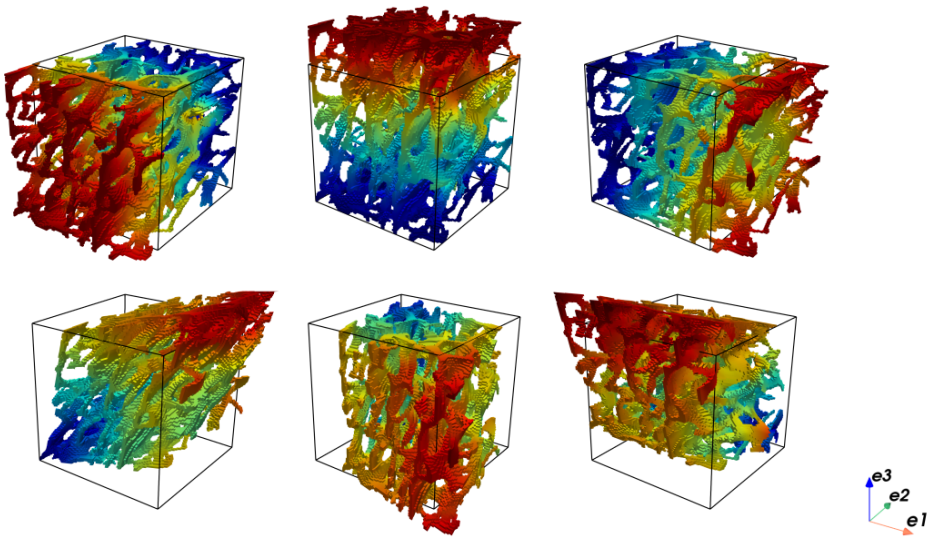


Downsampling (Factor 4)
Segmentation

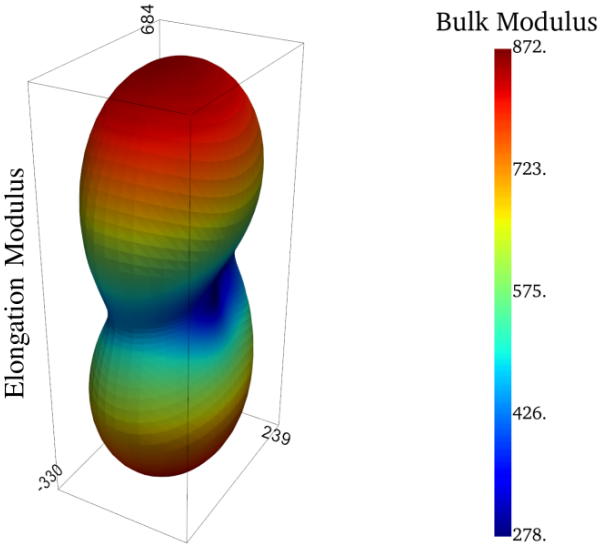


Morphometry
Fabric

Abaqus 2023



Homogenization (KUBCs)



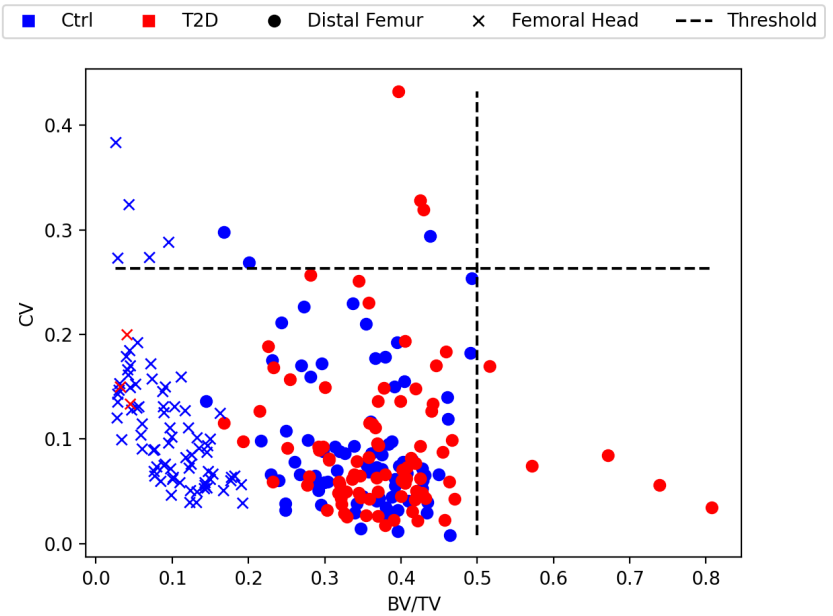
Stiffness Tensor

Bone Volume Fraction and Fabric

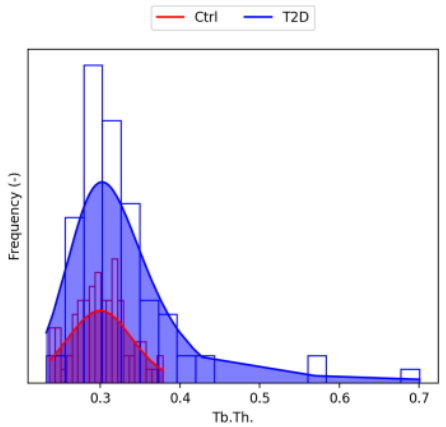
Thresholds

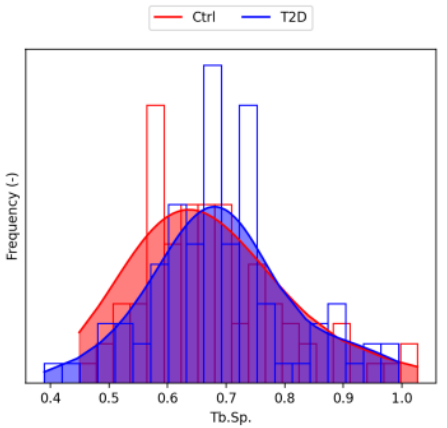
- Trabecular bone sample: BV/TV < 0.5
- Homogenous mass distribution: CV < 0.263 [1]

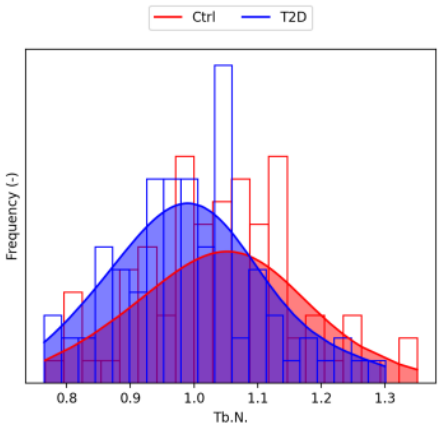
Femoral head samples only

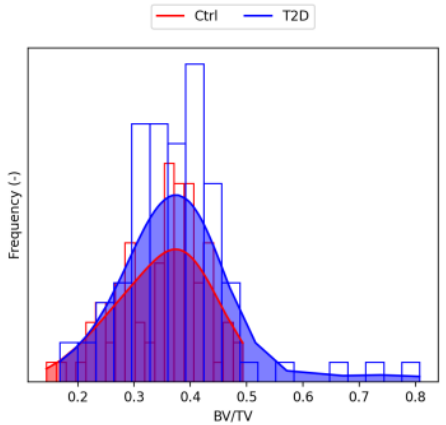


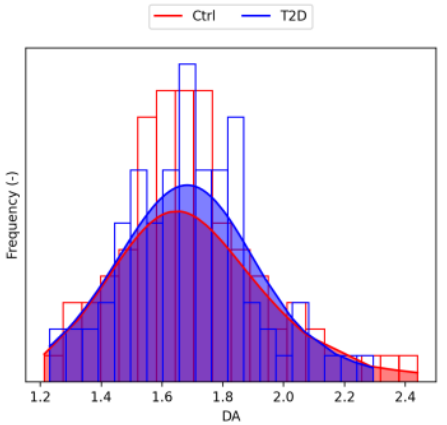
Morphometry - Distributions

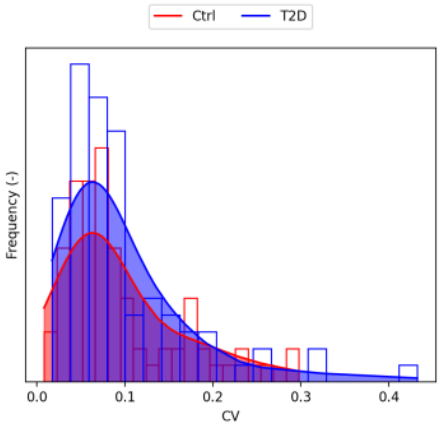










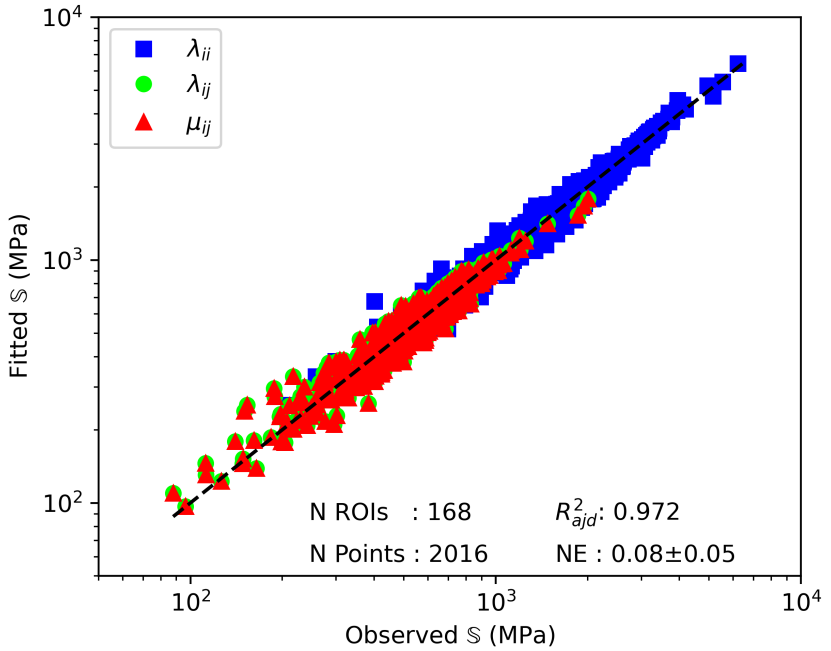


Morphometry - Statistics

Variable	Distribution	Variances	Test	p-value	Ctrl	T2D
BV/TV	Not-normal	Equal	Mann-Whitney	0.17	0.35 ± 0.07	0.38 ± 0.10
Tb.N.	Normal	Equal	t-test	<0.01	1.04 ± 0.12	0.99 ± 0.11
Tb.Th.	Not-normal	Not-equal	Permutation	<0.01	0.30 ± 0.03	0.33 ± 0.07
Tb.Sp.	Not-normal	Equal	Mann-Whitney	0.11	0.67 ± 0.12	0.69 ± 0.12
Tb.Sp.SD	Not-normal	Not-equal	Permutation	<0.01	0.08 ± 0.01	0.09 ± 0.04
DA	Not-normal	Equal	Mann-Whitney	0.86	1.70 ± 0.23	1.69 ± 0.20
CV	Not-normal	Equal	Mann-Whitney	0.84	0.09 ± 0.07	0.10 ± 0.07

Grouped Linear Regression

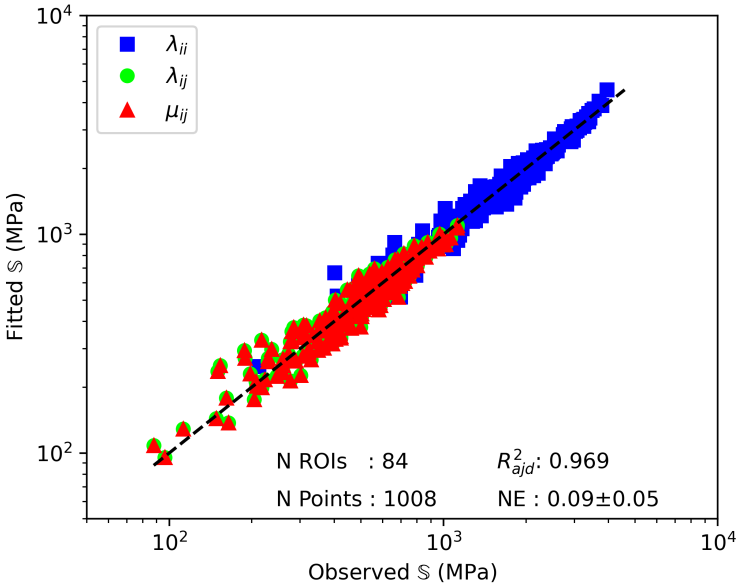
Matching femoral head Ctrl with T2D for BV/TV and DA [2]
$\Rightarrow$ 28 pairs of samples



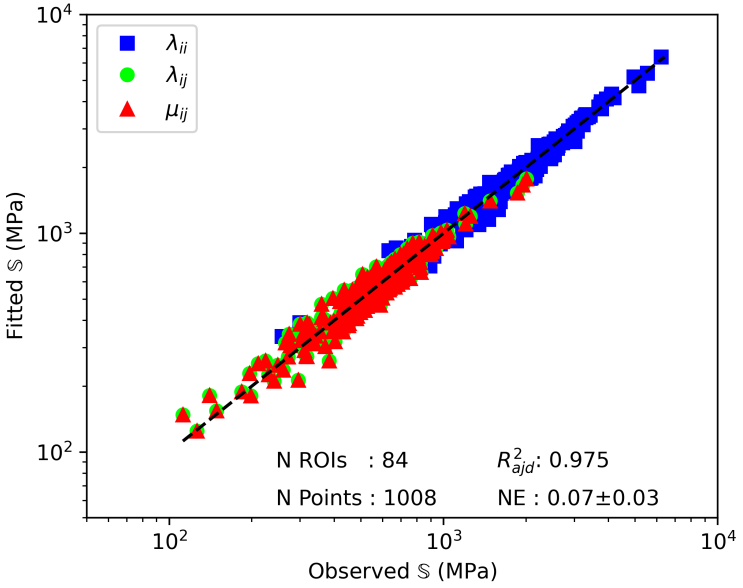
Separated Linear Regressions

Similar regression quality

Control

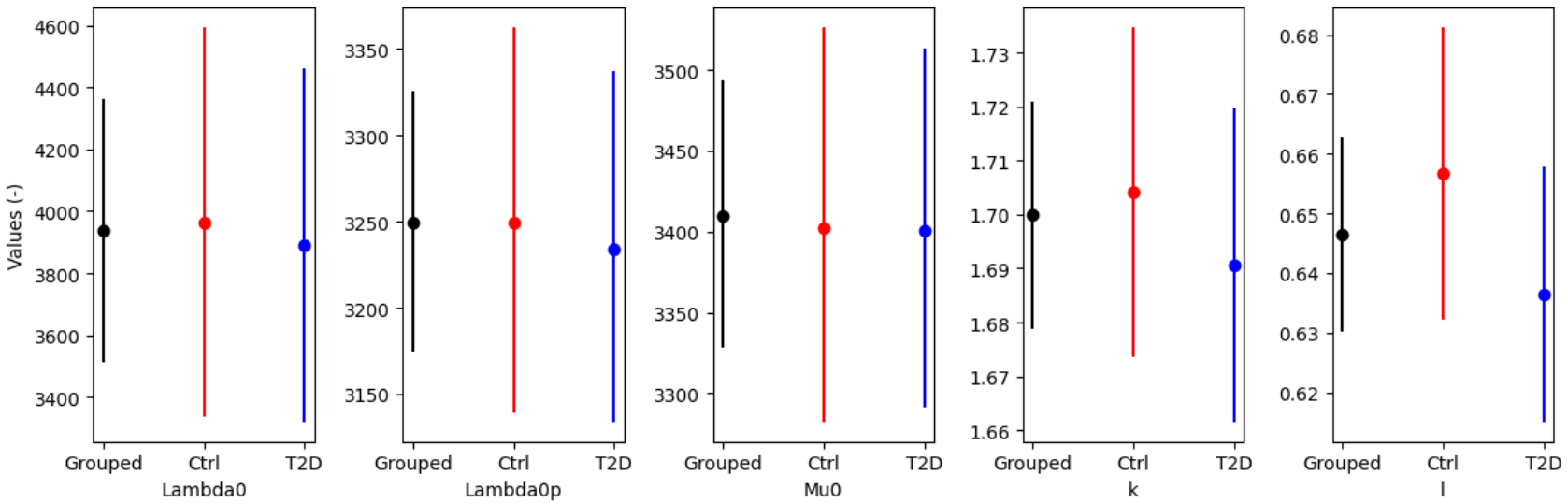


T2D



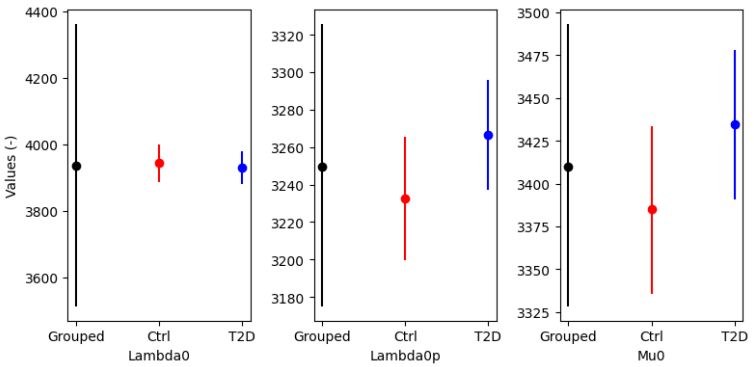
Separated Linear Regressions

Parameters
⇒ Overlapping confidence intervals

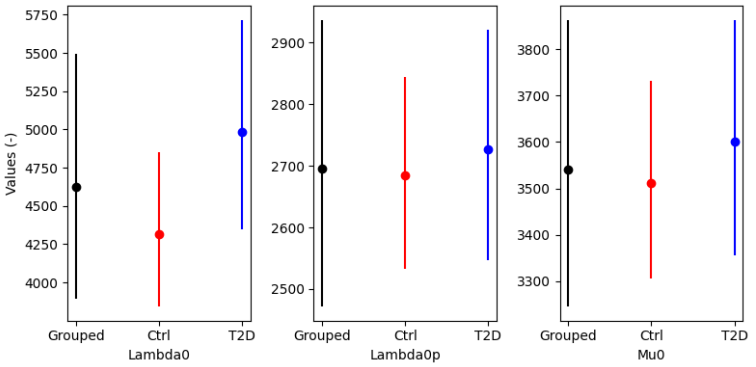


Stiffness Constants Comparison

Fixed exponents
$\Rightarrow$ Overlapping confidence intervals



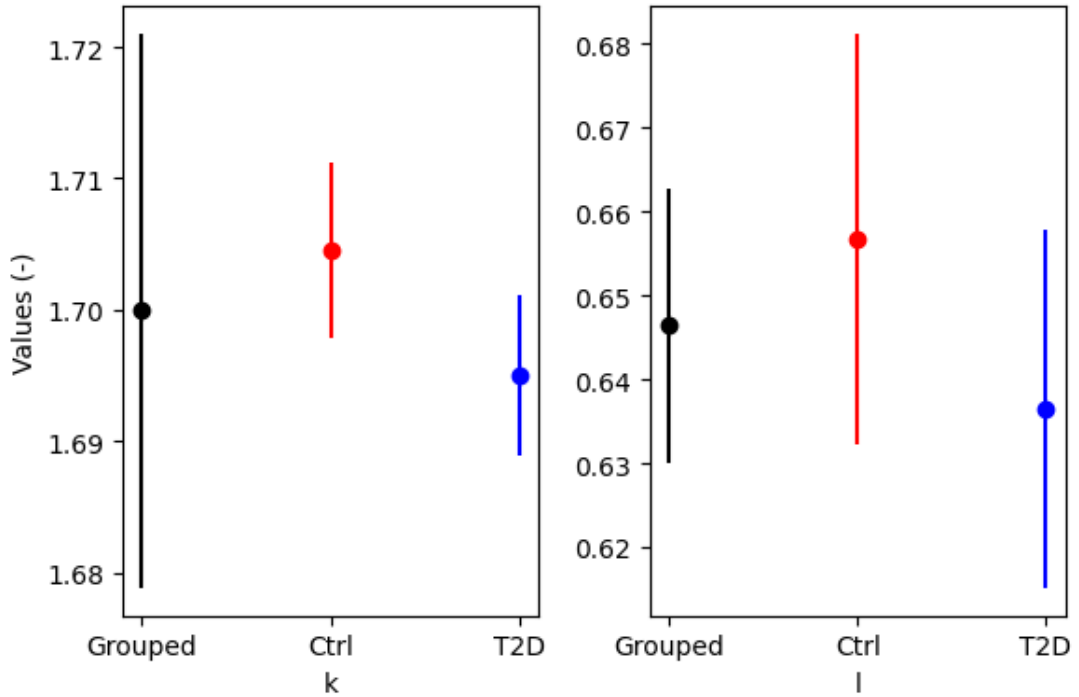
Present Study



Simon et al. [2]

Exponents Comparison

Fixed Stiffness Constants
$\Rightarrow$ Overlapping confidence intervals



References

- Panyasantisuk, J., Pahr, D. H., Gross, T., and Zysset, P. K. (2015)

  Comparison of Mixed and Kinematic Uniform Boundary Conditions in Homogenized Elasticity of Femoral Trabecular Bone Using Microfinite Element Analyses

  J Biomech Eng., 137(1)

  https://doi.org/10.1115/1.4028968

- Simon M., Indermaur M., Schenk D., Hosseinitabatabaei S., Willie B.M., Zysset P. (2022)

  Fabric-elasticity relationships of tibial trabecular bone are similar in osteogenesis imperfecta and healthy individuals

  Bone, 155

  https://doi.org/10.1016/j.bone.2021.116282