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Trabecular distribution of distal femur in extant apes

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Extant great apes are often used to model aspects of fossil hominin locomotor behaviours. Comparative investigation of trabecular bone, which (re-)models to reflect loads incurred during life, can provide novel insights into the locomotor reconstruction of fossil taxa [1]. Here we analyze the distal femoral epiphysis of [italics]Homo sapiens[italics] (N = 26), [italics]Gorilla gorilla[italics] (N = 14), [italics]Pan troglodytes verus[italics] (N = 15), and [italics]Pongo[italics] sp. (N = 9) to determine how variation in trabecular structure reflects differences in locomotor behaviours. Canonical holistic morphometric analysis (cHMA) of relative bone volume fraction (rBV/TV) and degree of anisotropy (DA) is used to infer patterns of joint loading in extant taxa.

A principal component analysis of rBV/TV and DA distributions show clear separation between taxa. Trabecular distribution in humans is consistent with medial (due to the ground reaction forces) and lateral (due to the resistance of the knee adduction moment provided by the quadriceps and gastrocnemius muscles and lateral collateral ligament) loading. Distribution in non-human apes is consistent with primarily medial loading due to the higher knee adduction moment, varus angle and ground reaction forces. Signals of a more extended knee in female gorillas compared to males (or chimpanzees) may reflect a more extended knee position during vertical climbing and higher arboreality in females [3]. Orangutans showed the most homogenous distribution of trabecular structure across both condyles, consistent with more variable knee joint postures. These results provide the comparative context to interpret knee posture and, in turn, locomotor behaviours in fossil hominins.

References: [1] Georgiou, L., Dunmore, C. J., Bardo, A., Buck, L. T., Hublin, J. J., Pahr, D. H., ... & Skinner, M. M. (2020). Evidence for habitual climbing in a Pleistocene hominin in South Africa. *Proceedings of the National Academy of Sciences*, 117(15), 8416-8423. [2] Bachmann, S., Dunmore, C. J., Skinner, M. M., Pahr, D. H. and Synek, A. (2022). A computational framework for canonical holistic morphometric analysis of trabecular bone. *Scientific Reports*, 12, 1-13. [3] Isler, K. (2005). 3D-kinematics of vertical climbing in hominoids. American Journal of Physical Anthropology: The Official Publication of the American Association of Physical Anthropologists, 126(1), 66-81.

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