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morphomap: an R package for analysis of diaphyseal cortical thickness, shape and cross-sectional geometry

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The cross-sectional geometry of long bones is commonly used to infer their biomechanical properties in investigations of past and present primate locomotion as well as to assess intensity and repetitiveness of physical activities, and to estimate body mass. While cross-sectional geometry has proved to be very useful for reconstructing bone loading patterns, a limitation of the technique has been that only a few cross sections along the diaphysis can be analyzed. The advent of virtual imaging and image processing offers the prospect of semi automating the sectioning and calculation of geometric properties at high resolution. We present the morphomap package, developed in the R environment, to extract cross sections from long bone meshes at specified intervals along the diaphysis and to calculate two and three dimensional morphometric maps, cross-sectional geometric parameters, and semilandmarks on the periosteal and endosteal contours of each cross section. We demonstrate the validity of this computational tool by showing that it obtains the same results as those from manual and other computational approaches. We then demonstrate the functionality of morphomap in a comparison of human and chimpanzee femora. The tool produces 61 cross sections along each diaphysis, at increments of 1% between 20% and 80% of their biomechanical length, automatically draws morphometric maps and calculates the parameters described above. The results illustrate the potential of morphomap in identifying differences in diaphyses that can be related to differences in locomotion and lifestyle in living and fossil primates.

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