Title: Human calcaneal external shape relative to activity and foraging levels

Authors: Christine M. Harper, Christopher B. Ruff, Adam D. Sylvester

Affiliations: Center for Functional Anatomy and Evolution, The Johns Hopkins University School of Medicine

Abstract Text:

The role of the calcaneus in weight-bearing suggests that it may reflect differences in activity and foraging levels among different modern human populations. While lower limb cortical and trabecular bone have been demonstrated to vary with regard to human behavior, human calcaneal variation has not been studied in this context. Here we analyze the entire calcaneal external shape of recent industrialized modern humans (n=60), Native American agriculturalists (n=47), a transitional Native American population that had not fully adopted agriculture (n=10), and Late Stone Age Khoesan hunter-gatherers (n=13).

Calcanei were either surface or micro-CT scanned and their external shape analyzed using a three-dimensional geometric morphometric sliding semilandmark analysis. Semilandmarks were allowed to slide relative to an updated Procrustes average to minimize the bending energy of the thin plate spline interpolation function. Final landmark configurations were aligned using a Generalized Procrustes Analysis. Shape variation was summarized using a principal components analysis. Procrustes distances between different human populations were calculated, and resampling statistics run to test for significant differences.

All human populations demonstrate statistically different calcaneal morphologies ($p<0.005$ for all comparisons). Industrialized and non-industrialized populations separate from each other across the first six principal components (52.34% of variance). Non-industrialized populations demonstrate a mediolaterally wider and superoinferiorly taller posterior calcaneus and tuber, as well as a larger peroneal trochlea. This greater robusticity is likely adapted for the increased load through the calcaneus associated with a non-sedentary lifestyle. The industrialized sedentary modern humans, however, possess a relatively larger lateral plantar process, potentially as a compensatory mechanism for bipedal behaviors in a generally less robust and more antero-posteriorly elongate calcaneus.

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