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Evaluating behavioral effects on modern human shape talar through GMM

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It is known that talar shape varies among hominoids related to differences in locomotion and substrate use [1,2,3]. However, less is known about variability in talar morphology within modern humans [4]. Here we apply (semi)landmark-based methods to explore talar morphological variation between groups of modern humans with different subsistence economies and lifestyles. A template consisting of 15 landmarks, 105 curve semilandmarks and 131 surface semilandmarks was digitized on 3D models of 94 left modern human tali (26 hunter-gatherers, 15 mountain dwellers and 53 farmers). Generalized Procrustes superimposition [5] and Principal Component (PC) analysis based on the group mean covariance matrix was used to explore shape variation within talus models. An Analysis of Variance (ANOVA) was conducted to identify group differences along each PC. Shape variation related to static allometry was investigated by Pearson product-moment correlation coefficients (r) of shape variables (PCs) against the natural logarithm of centroid size.

The first three PCs describe 78.6% of variation in the sample, with PC1 (56.3%) separating hunter-gatherers from farmers/agriculturalists. Positive values along PC1 (hunter-gatherers) reflect mediolaterally wider and dorsoplantarly compressed corpora with enlarged talar necks and heads. Negative values along PC1 (sedentary groups) reflect more cuboidal corpora, a less posteriorly-extended flexor hallucis longus groove, and reduced anterior extension of trochleae and smaller talar heads. Results demonstrate that human talar shape may be influenced by loading differences, presumably due to a combination of substrate/terrain use, lifestyle (nomadic vs. sedentary) and subsistence strategy, resulting in different arthrokinematics during weight bearing by the talus over the course of stance phase (load-bearing). These results could have important implications for the interpretation of fossil specimens and inferring likely ranges of joint movements (arthrokinematics) in extinct taxa. Future studies could increase the sample size to test the effects of subsistence economy and different patterns of mobility.

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