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Structural Differences in the Tibial Metaphysis Between Female NCAA Division I Cross-Country Runners and Gymnasts

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Bone geometry and microarchitecture vary between athletes with different habitual loading patterns because bone adapts to withstand loading demands. As gymnastics involves infrequent high impact loading and running involves repetitive medium impact loading, differences in the tibial structure are expected between these athletes. **PURPOSE:** Investigate differences in geometry and microarchitecture of the distal tibial metaphysis between collegiate female athletes competing in gymnastics and cross-country. **METHODS:** High resolution peripheral quantitative computed tomography was used to assess the distal tibia of NCAA Division I female cross-country runners (n = 17, age = 19.0 ± 0.9yrs, BMI = 20.6 ± 1.4kg/m^2) and gymnasts (n = 16, age = 19.5 ± 1.4yrs, BMI = 23.3 ± 1.8kg/m^2). Scans were taken at 4% of tibial length and evaluation software measured bone parameters. Finite element analysis estimated stiffness and failure load. Unadjusted group comparisons were conducted using independent samples *t* tests, followed by analysis of covariance adjusting for baseline BMI. Data are presented as mean±SD, α=0.05, two-sided. **RESULTS:** Unadjusted group comparisons showed that gymnasts exhibited greater total area (1067.4±100.3mm^2, 950.8±65.9mm^2, p<.001), trabecular area (995.5±103.2mm^2, 880.7±64.5mm^2, p<.001), and trabecular number (2.1±0.2mm^{-1}, 1.9±0.2mm^{-1}, p=.015) than runners. Stiffness (228.7±47.5Nmm^{-1}, 190.5±46.9Nmm^{-1}, p=.027) and failure load (12.2±2.4N, 10.3±2.4N, p =.026) were also greater in gymnasts than runners. Group differences analyzed after adjusting for BMI remained significant for total area (p=.030), trabecular area (p=.020), and trabecular number (p=.008); whole bone stiffness and failure load were no longer significant (p≥.381). Cortical volumetric bone mineral density, area, and thickness were not significantly different between groups in either analysis (p>.05). **CONCLUSION:** Gymnasts presented with more favorable bone structure than runners, possibly

due to higher forces experienced during training and competition. Differences in tibial metaphysis bone structure between gymnasts and runners, which persist after controlling for BMI, indicate that the adaptive bone formation response to sport training is specific to demands of the sport.

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