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Abstract:

Fracture risk and mechanical competence of bone are functions of bone mass and tissue quality, which in turn are dependent on the bone's mechanical environment. Male mice have a greater response to non-weight-bearing exercise than females, resulting in larger, stronger bones compared with control animals. The aim of this study was to test the hypothesis that short-term weight-bearing running during growth (21 days starting at 8 weeks of age; 30 min/day; 12 m/min; 5° incline; 7 days/week) would similarly have a greater impact on cross-sectional geometry and mechanical competence in the femora and tibiae of male mice versus females. Based on the orientation of the legs during running and the proximity of the tibia to the point of impact, this response was hypothesized to be greatest in the tibia. Exercise-related changes relative to controls were assayed by four-point bending tests, while volumetric bone mineral density and cross-sectional geometry were also assessed. The response to running was bone- and gender-specific, with male tibiae demonstrating the greatest effects. In male tibiae, periosteal perimeter, endocortical perimeter, cortical area, medial–lateral width and bending moment of inertia increased versus control mice suggesting that while growth is occurring in these mice between 8 and 11 weeks of age, exercise accelerated this growth resulting in a greater increase in bone tissue over the 3 weeks of the study. Exercise increased tissue-level strain-to-failure and structural post-yield deformation in the male tibiae, but these post-yield benefits came at the expense of decreased yield deformation, structural and tissue-level yield strength and tissue-level ultimate strength. These results suggest that exercise superimposed upon growth accelerated growth-related increases in tibial cross-sectional dimensions. Exercise also influenced the quality of this forming bone, significantly impacting structural and tissue-level mechanical properties.