Exercise during growth provides lifelong benefit to bone structure and strength: a case study

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Abstract

Exercise induces greatest gains in bone health during skeletal development, yet reduced bone strength is predominantly an age-related phenomenon. This dichotomy has raised the question of whether exercise-induced changes in bone health when young persist into late adulthood where they may have benefits on bone health and fracture risk. Previous work has suggested exercise-induced gains in bone mass are lost with aging; however, 1) exercise during growth predominantly influences bone structure rather than mass to increase bone strength and 2) mechanisms exist for the long-term maintenance of exercise effects on bone structure. The aim of the current case was to explore whether exercise-induced gains in bone structure and strength accrued when young persist lifelong. The subject was a 94-year-old former Major League Baseball (MLB) pitcher who played competitively for 20 years before ceasing play in 1955. Throwing athletes are a unique model to investigate the skeletal effects of exercise as: 1) the unilateral upper extremity loading associated with throwing enables the contralateral side to serve as an internal control site and 2) throwing athletes have large dominant-to-nondominant (D-to-ND) differences in midshaft humeral bone properties. Peripheral quantitative computed tomography slices of the subject's dominant and nondominant humerii were taken at 50% humeral length, and D-to-ND percent differences in bone properties calculated and compared to those observed previously in non-throwing controls. Exercise when young had no lasting effects on D-to-ND difference in cortical bone mass or area; however, D-to-ND difference in total area was nearly 3-times that observed in controls. The maintenance of exercise effects on total area resulted from persistence of benefits on periosteal perimeter, with the loss of cortical bone mass and area benefits being due to greater endosteal expansion (perimeter). As a result of the maintenance of exercise-induced benefits on bone structure, D-to-ND difference in ability to resist torsional forces (polar moment of inertia) was nearly double that observed due to habitual loading associated with arm dominance in controls. The maintenance of exercise-induced benefits on bone structure in the current case, despite exercise ceasing 56 years ago, supports the hypothesis that exercise when young can have lasting benefits on bone strength independent of maintenance of bone mass effects. This question is being further explored in a cohort of 100 former MLB players and 100 matched controls.