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Army Basic Combat Training Affects Bone Formation, Remodeling in Women

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Female U.S. Army recruits who underwent 8 weeks of basic combat training experienced marked changes in bone microarchitecture and key biomarkers of bone metabolism, according to findings from an observational study utilizing high-resolution bone imaging.

Stress fractures are common during periods of heightened physical activity, such as Army basic combat training, when recruits typically undergo 8 to 12 weeks of intense activities that include running, calisthenics and marching, **Julie M. Hughes, PhD,** a research physiologist with the military performance division of the U.S. Army Research Institute of Environmental Medicine, and colleagues wrote in the study background. During basic combat training, up to 5% of men and 20% of women sustain a stress fracture, researchers noted, with the most common fracture sites being the tibia, fibula and metatarsals, followed by the femur and pelvis.

“There are multiple factors affecting stress fracture risk, but notably the pathophysiology that underlies stress fracture is not well-understood,” the researchers wrote. “In simple terms, stress fractures result when the transient deleterious effects of bone remodeling outpace the protective effects of adaptive bone formation. Thus, understanding the magnitude and extent of these bone changes during [basic combat training] may lead to new insights into stress fracture etiology.”

Hughes and colleagues analyzed data from 91 female basic combat training recruits from Fort Jackson, South Carolina, aged 17 to 42 years (mean age, 21 years) and without self-reported history of an endocrine disorder within 2 years. Women underwent military-specific training for basic combat training, including road marches carrying heavy loads, running, resistance exercises, hand-to-hand combat training and weapons training. Women provided fasting blood samples at baseline and 8 weeks for the measurement of bone formation markers, including bone alkaline phosphatase, osteocalcin, osteoprotegerin, tartrate-resistant acid phosphatase 5b (TRAP5b), C-telopeptide cross-links of type 1 collagen (CTX) and procollagen I N-terminal propeptide (P1NP), as well as sclerostin, soluble RANK ligand, intact parathyroid hormone and serum 25-hydroxyvitamin D. All women underwent high-resolution peripheral quantitative CT to assess bone density, microarchitecture and strength at the distal metaphyseal and diaphyseal regions of the tibia.

Bone density, microarchitecture

Researchers used linear mixed models to estimate the mean difference for each outcome from baseline to 8 weeks, adjusting for race, age and BMI.

After 8 weeks of basic combat training, researchers observed changes at the metaphyseal region of the distal tibia, including mean increases in trabecular thickness (1.13%), trabecular number (1.21%), trabecular bone volume/total volume (1.87%), trabecular volumetric bone mineral density (2.01%) and cortical thickness (0.98%). Mean trabecular separation decreased (–1.09%) as did cortical volumetric BMD (–0.34%) and cortical tissue mineral density (–0.38%). There were no observed changes in cortical porosity, according to researchers.

Circulating bone biomarkers

In addition to changes in bone density, researchers also observed changes in key biomarkers of bone metabolism, including a decrease in serum sclerostin, a negative regulator of bone formation (mean decrease, –5.7%). Bone alkaline phosphatase increased by a mean of 26.2%, whereas P1NP was unchanged. Markers of bone resorption, including TRAP5b and CTX, increased by a mean of 19.1% and 10%, respectively, according to researchers. Levels of 25-(OH)D also increased by a mean of 28% from baseline to 8 weeks, whereas parathyroid hormone levels remained stable during training.

The researchers noted that women who experienced the greatest change in trabecular volumetric BMD (mean, 6.4%) from baseline to 8 weeks had lower baseline trabecular volumetric BMD and were more likely to exercise less than 2 days per week in the 30 days before basic combat training (P = .05) vs. women with the smallest increase in trabecular volumetric BMD (mean, 0.57%). Additionally, women with the greatest decline in cortical volumetric BMD from baseline to 8 weeks (mean, –9.26%) were more likely to have vitamin D deficiency at baseline vs. women with the least decline in cortical volumetric BMD (mean, 2.93%; P = .04).

“To our knowledge, this is one of the first studies to demonstrate specific changes in trabecular and cortical bone density and microarchitecture in women during a relatively short period (8 weeks) of unaccustomed physical activity,” the researchers wrote.

The researchers added that the findings provide evidence that changes in bone microarchitecture can be captured when physical training is combined with high-resolution bone imaging. – *by Regina Schaffer*

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